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THE OVERHEAD WIRE QUESTION ABROAD.

PERHAPS the underwriters of Boston, in threatening to raise the fire premiums on electric lighting risks, had more show of reason than we at first gave them credit for, seeing that the special committee on mercantile affairs and cities of the Massachusetts Legislature has been, and is still, investigating the alleged danger to life and property from overhead wires, and is also considering a petition from the Citizens' Association of Boston for the constitution of a Board of Commissioners to enforce the substitution of underground wires for the present overhead system. The insurance companies may have felt that while the public bodies and the electric light companies were debating the question, each from their own point of view, and the result remained undecided, the only means of preventing slovenly and dangerous work being put into installations would be found in creating a "standard" risk, any departure from which would be attended by such an increase in premium as to render scamping almost impossible. Although the public would prefer that all wires be placed out of sight, the lighting companies do not appear to be of that opinion, and ironically thank the Citizens' Association for endeavouring to regulate the people's affairs, declaring, too, that they are not opposed to placing their wires in underground conduits, but that they cannot see their way to doing so without detriment to the public service or bankruptcy to the electric companies, the difficulties to be encountered being more than mechanical. The danger might even arise of a discontinuance of the electric supply, or of a much enhanced price. The suggestion that the Board of Control shall consist of a lawyer, an electrician, and a civil engineer is not approved of; the civil engineer might be fit for the post, but not the lawyer or the electrician, the latter profession apparently being one that is deemed by people on both sides of the Atlantic sufficient to remove its devotee beyond the pale of truthfulness and moral rectitude. It is not considered necessary to alter the system of running the mains, at least not from any danger at present to life or property, it being stated that no business on the same scale has been conducted with so little damage to human life and limb, and small loss of property, as the electric lighting industry. All that is required to be done is to remove the dead wires, and regulate the overhead system generally.

The number of people killed by electric shock in Boston in 1886 was one; in 1887 one person only was killed by electric shock, while 130 persons were killed by other accidents; of these deaths, coal gas was answerable for one, soothing syrup for two, and railways for 92. Since June, 1888, when an Act came into force compelling the electric light companies to make report of any and every accident that may take place through their installations, not a single mishap has occurred; on the other hand, four cases of accidents from the use of gas have been reported.

In the last fire report of the City two fires, or one-seventh of one per cent. of the whole number of fires, are set down to being caused by electricity; the percentage of monetary loss thereby is unfortunately omitted. Matches, assisted by children and rats, are responsible for no less than 20 per cent. of the total fires. Not one fire arose from a faulty outdoor wire, either overhead or underground, but the houses were set on fire by indoor wires, which had been injured by careless use, by the abrasion of the insulation, or by short circuits through nails being accidentally driven into contact with the two wires. Judging from these data, overhead wires cannot be charged with causing any very serious destruction to life or property.

Before laying the wire in conduits underground, the insulation problem must be solved. Some cable manufacturers claim to have done this, and say they will guarantee a cable for three or five years. This warranty is useless unless it covers the cost of cables and indemnity against loss of business and damage by explosions or fires which may be caused by their use.

The greatest difficulty to contend with in underground work is the constant and unavoidable accumulation of gases, and the explosions which result therefrom. The streets of Boston are permeated—or, rather, saturated—with coal gas, sewer gas, and exhalations from the soil, and it is impossible to get rid of them. The gas leakage is set down by experts at 7 per cent. of total output as a minimum, rising up to 17 or 18 per cent. Now, conduits involve the use of manholes—large pits with heavy cast iron covers. When the gases accumulate in these manholes there is sure to be an explosion, irrespective of the electrical question. This was the cause of the explosion which recently took place in New York. In addition to the accumulation of these gases, the moisture or the abrasion of the cable caused by the necessary bending in being wound upon a drum and in going down into the manholes, and then through the ducts, permits leakage of the electric current, the gas is instantly ignited, and there is an explosion. There is no danger from overhead wires, because there is nothing to explode. The *New York Herald* of March 29th ult. comments thus on one of the recent explosions :—Subway cannonading—Three loads of paving stones fired from manhole in front of the Fifth Avenue—Many shocked, but none hurt—Accumulated gas to blame—No live wires to set off the mines.

The chief objection to conduits is the danger from the multiplication of these manholes or receptacles into which the gas can enter and mix with air, and when electric wires are placed in the subways the electric spark will sometimes explode the mixture.

To remedy this defect in underground receptacles an endeavour has been made to ventilate them by a fan, but this was only partially successful, and had to be abandoned.

Presuming the wires to be laid in conduits in such a manner that their insulation shall be perfect and the ventilation of the receptacles secured, there still remains the question of what is called "distribution" to be overcome. Current has to be taken from the main circuits in order to get light into the houses. The cable runs from one manhole to another, but the light has to be furnished here and there along a street and in adjoining blocks. The wires have therefore to be brought out of these manholes, and this can be done in two ways : They can be run underground to the building, then up the side of this building to the house-tops, and across the house-tops to the point where the light is wanted ; or the wires can be suspended along the front of the buildings, and thence taken into the houses. In Boston the distribution is nearly entirely carried over the house-tops.

What advantage then—say the electric light companies—will be gained by the compulsory removal of overhead wires ? Nothing except æsthetically, and for that slight non-commercial improvement is the present simple, and free and easy or go as you please system, to be demolished and replaced by one more expensive, more dangerous, and more troublesome to deal with ? The only underground system the electrical interest would not oppose—cellar distribution—is not feasible in their city. The commercial results of the underground system, even if it were otherwise desirable, would be ruinous to the companies, involve a very large increase in the prices to customers, and at the same time a very great deterioration in the character of the service rendered. One company which uses a high tension current has already expended $550,000 on overhead wires and structures ; to put the wires underground would incur a further outlay of over $1,000,000 extra without a corresponding benefit being reaped, and the contention is that a revolution is not needed for the purpose of straightening wires or making them go at right angles instead of zig-zag, or for the purpose of painting posts one colour or another, or for the removal of all useless wires ; again, disaster would result from the change, as underground systems have up to now failed wherever tried, and the end would be to cripple an important and growing industry. The inferences to be drawn from the above statements differ, we think, considerably from the conclusions arrived at therein. In the first place, house-top distribution being in use, very little alteration comparatively would be necessary beyond the rearrangement of the supply mains ; and again, the house-top system necessitates a minimum number of points at which the main would be tapped as well as a minimum interference with the wires when once laid in the proper channel underground. The ventilation of the man-holes does not present an insuperable difficulty, while the danger to be feared from leakage from underground wires would be nothing compared with such a disaster as might occur from the sudden downfall of overhead wires carrying high tension currents, the anticipated fearful results of which could only be delineated or contemplated by a Mark Twain.

THE report of the Metz Gas Company states that there has been a diminution of receipts and of profit, owing partly to the Municipality having introduced economies, and partly to the use of the electric light at the railway station. The consumption of gas by the general public has, however, increased. At the general meeting of the company the directors have been empowered to establish a small central electric light station for such of the customers who wish to adopt the new light. At Malaga, the report of the local gas company states that the experiments undertaken are approaching a termination, and it is considered advisable to establish a small electric light station. The shareholders have instructed the directors to act as they think best fit for the interests of the company. The directors of the Montauban Gas Company have been authorised to establish a central electric light station. At Angers, the consideration of the matter has been postponed until the exhibits at the Paris Exhibition have been examined, with a view to finding out the best system. A credit has been voted by the shareholders of the Florence Gas Company for the establishment of an electric light station. The directors of the gas company at Perpignan admit that they have felt the competition of the new central station in that town, their profits having diminished considerably in consequence.

THOSE having business to transact at the Paris Exhibition will be pleased to learn that the Minister of Posts and Telegraphs has made arrangements whereby visitors and exhibitors will be able to receive and forward their correspondence without leaving the precincts. A temporary postal and telegraph office, with telephone cabins, will be open the whole time of the duration of the Exhibition. All the ordinary operations of the postal service will be carried on. Besides the interior service, special to the Exhibition, the office will receive any letter or other communication for Paris, the departments, and the nations comprised in the international conventions. Exhibitors will also be able to have their letters and telegrams addressed to the places where their exhibits stand or *poste restante*. Those exhibitors on the Quai d'Orsay and the Esplanade des Invalides will specially benefit by these arrangements. In addition, letter boxes will be placed in the principal thoroughfares of the Exhibition. The deliveries will be as follows :—The first at 7.30 in the morning ; the second at 9 ; the third at 11.30 ; the fourth at 1.30 in the afternoon ; the fifth at 3.30 ; the sixth at 5.30 ; the seventh at 7.30.

THE communication of Messrs. Ganz & Co., which we print on another page, would have been far more interesting had it been accompanied by a general description of the alternate current motor of which the designers expect such wonderful results. It is estimated that the commercial efficiency of some moderate sized motors now in hand will be 90 per cent., that they will be self-regulating, self-starting, and that only one circuit will be required ; in fact that they will be superior in almost every respect to continuous current motors, especially for the transmission of power to very large distances. The figures given in the table teach us very little, and in the absence of descriptive matter, which may be withheld for good reasons, we should have liked some practical data concerning the performance of the experimental machine which formed the basis of the present communication, and probably that for the sanguine expectations of Messrs. Ganz & Co. It seems to us that the figures given are all calculated, and instead of the "Performance of motor" being given in watts and electrical horse-powers, we should have preferred brake power in one column and the electrical energy consumed in another. This alone would give us a clear idea of the commercial efficiency. We should be glad to receive such data in lieu of the calculated figures in the table.

JUDGE WEATHERBE on "Hemp-covered Cables," says : "Grasp firmly, so as to prevent untwisting the end, and uncoil a length of about 30 fathoms of cable, firmly lashing the end in a fixture." This actual experiment of the learned Judge is absolute proof of the contrary of what he states, and at the same time shows his absolute ignorance of how cables are made, and how cables should be handled. If, as he supposes, the cables were manufactured into a state of torsion, then the peculiar method he adopts of uncoiling would remove torsion by undoing the twist, and no result would be obtained such as he describes. But the manner in which it is uncoiled puts a twist into each convolution of the cable ; consequently if the coil be small, there will be many twists violently put into the 30 fathoms ; such being so, the results obtained are just what would be expected.

THE manufacture of an iron-covered submarine cable, and the method in which it is coiled, does not appear to be understood by Judge Weatherbe. It is the same in the States as it is in this country, and the great object has always been successfully accomplished, too, of making a cable in such a manner that there is neither twist nor torsion in any portion of it, especially so far as the outside sheathing is concerned. The earliest machines for sheathing submarine cables were those designed by R. S. Newall & Co. and Kuper & Co., and these were provided with what is commonly called the "sun and planet" motion, having for its result the laying on of each individual wire without any twist or torsion. This plan, or one similar, is invariably employed in covering a cable with its external protection, the iron wires being wound helically around the core without any twist or torsion whatever.

CONSEQUENTLY the wires in a properly manufactured cable cannot be in the condition of torsion imputed to them. This can be easily seen on examination ; but if the wires should show signs of being "twisted" the conclusion is that the cable has been sheathed by means of an imperfect machine. This portion of the manufacture of a cable will be found very lucidly described in the "Cantor" lectures by the late Fleeming Jenkin. We recollect that his description and illustrations were exceedingly simple and self-evident.

THERE is one other point respecting the behaviour of a somewhat rigid rope, like a submarine cable ; that is during the process of "coiling" within a tank, and also uncoiling from the same place. It may appear very simple, but has any one watched a "land-lubber" trying to coil a soft rope the wrong way ? In coiling a cable into the tank on board a ship, it all appears to go in very smoothly ; but it has to go in one direction, and in going in this direction for every turn round the tank there is one complete "twist" put into that section of cable. One complete twist in every turn round the tank. This twist in a circular tank is so distributed through the long length of the turn as to be imperceptible, but in oval or irregularly shaped tanks it will frequently show itself. In uncoiling a cable or paying it out from the tank, the opposite effect takes place, for each coil of the cable in the tank as it comes out receives a twist in the opposite direction, or "untwist," the result being that this operation of uncoiling "untwists" the cable and neutralises or takes out the twist already put in, having as a resultant the cable leaving the ship without any twist or torsion in it whatever ; practically, therefore, the cable lies at the bottom of the sea in the same condition as when it left the machine. In circular tanks this twisting and untwisting is very gradual, and practically is hardly noticed, but in oval shaped tanks the twist is there and the untwist is there, and when these come together and neutralise each other the result is very plainly to be seen. With the use of cones and rings, as first introduced by Newall & Co., the effect of this neutralisation of the twist on the cable as it is being payed out is unnoticed, but for all that it takes place.

ELECTRIC LIGHTING AT HAVRE.

WHILST the attention of the profession in this country is being directed to the various electric lighting schemes now under consideration, it may be interesting to our readers if we place before them some details concerning a central station about to be erected in Havre, France. We learn from a French contemporary that the Havre Town Council have authorised Messrs. Ch. Mildé, Sons & Co. to erect the station, of which the following are the terms of subscription:—Persons desiring to be supplied with the electric light must subscribe for five years. The company undertake to furnish current to dwelling-houses and other establishments, but branch wires leading into them, fittings, &c., referring to the interior lighting will be put up at the cost of the subscriber, who must pay a small sum monthly for maintenance. The current will be supplied either at a fixed rate per lamp or by meter. In the latter case the meter, which will be stamped by the Town Council, will indicate the consumption of current in watt-hours, and the rent for the meter will be 2s. per month, including maintenance, and without considering its capacity. The price of current supplied through a meter has been fixed at about 1·2d. (12 centimes) per 100 watt-hours, and the minimum consumption per hour must not be less than 750. The following table shows the scale of charges for current not registered by a meter on the consumer's premises:—

PRICE PER LAMP PER MONTH.

Time of extinction.	Incandescent.		Arc.	
	10 C.P.	19 C.P.	336 to 480 C.P.	1,150 to 1,440 C.P.
10 p.m.	4s.	5s. 8d.	£2 16s.	£6
12.30 a.m.	6s.	9s. 8d.	£5 4s.	£11

The company will replace worn-out glow lamps at their own expense, but consumers must pay at the rate of 3s. 2d. for every broken lamp; arc lamps will be supplied and maintained by the company. Subscribers will be able to obtain current while the station is running—namely, from sunset (according to a previously determined hour) until 12.30 a.m.

In the specification approved by the municipality it is stated that the electric conductors must not be laid in the culverts, but under the causeway, in an earthenware, masonry, or metal conduit, at a depth of at least 40 inches, and distant by the same interval from the houses; and if transformers are used they must be placed in the dwellings. The concession has been granted for a period of 25 years without monopoly or privilege, the town reserving the right of granting similar concessions even for the district to which the one in question applies; but this power will not be put into force for the first five years of working, which are considered as a period of organisation. The company is granted the sole use of their conduits for the period of their concession, but the town is empowered to displace or remove at the cost of the company any portion or portions of the conduit which it may be necessary to do in the interests of the public or of the municipality. The maximum rate for current must not exceed 1·2d. per 100 watt-hours, but in the case of its being decided to light the municipal buildings by electricity, the price must be reduced by one-third and to one-half for the lighting of the streets. Current must be supplied to any one who asks for it along the route traversed by the mains, and the company are obliged to extend their mains when a certain demand for light is made. No meter will be allowed to be employed before it has been examined by a representative of the Town Council, in order to prove its exactness and efficiency. To show that the Havre municipality intend to considerably benefit by the erection of the station, we may mention that the concessionnaires have to pay to the former during the authorised period an annual rent of £4 per kilometre or fraction of a kilometre of longitudinal main laid in the streets to be served, and an allowance of 5 per cent. on the gross receipts. Should, however, current be supplied to factories or other establishments outside the town, the allowance will be raised to 6 per cent. The company have to commence lighting in eight months' time and satisfy all demands for current within two years; but should they fail to do so, the concession may be cancelled by the town.

The municipality reserve to themselves the right of redeeming the concession at any time after the expiration of the first 10 years, and the price will be determined in the following manner:—The average net profits for the last three years previous to purchase will be calculated, and the resultant amount will be paid to the company in the form of an annuity for each of the unexpired years of the concession. The town will purchase, according to their then value, the whole of the machinery, apparatus, tools, buildings, &c., the valuation to be made by an expert, and at the expiration of the concession the mains will become the property of the town. In order to determine whether the company fulfil all the conditions required of them, a commission, consisting of a town representative, the Prefect, and a representative of the company, will be appointed every five years. The commissioners will have the right of making any experiments they may think necessary, and the costs will be defrayed half by the town and half by the company. Four months after the nomination of the commission, the latter will send in their report to the Mayor, who three months subsequently may, upon the advice of the Town Council, order the company to proceed with any improvements or modifications proposed by the commission, and determine the time within which the alterations should be made. The modifications or improvements will, however, not be of such a nature as to bring the net profit of the shareholders below 6 per cent. dividend, neither will they cause the essential conditions of the constitution of the company to be changed, as for instance, by discontinuing the use of the system in use in order to introduce another.

ON THE SPEED REGULATION OF A MOTOR IN THE ELECTRICAL TRANSMISSION OF POWER.*

By M. MARCEL DEPREZ.

WE will call

E the electromotive force,
V the speed,
I the intensity of the general current,
R the total resistance of the two machines and the line.

(These letters being influenced by the index, $_0$, or the index, I, according to whether the generator or the receiver is being considered.)

First case.—The magnetic field and, consequently, the electromotive force of each machine (reduced to the unit of speed) are functions of I only when the inducing electro-magnets are simply placed in series in the principal circuit.

We get then

$$E_0 = V_0 \, f_0 \, (I), \qquad E_1 = V_1 \, f_1 \, (I).$$

If the inductors are double wound, as I proposed in 1881, that is to say, if one coil is traversed by the general current while the other is traversed by a constant current independent of the first and independent of the speed, we get the same expression for the electromotive force, the speed not entering into it under the term f_0 or f_1. It is with this hypothesis that we shall consider the problem, and it would be easy to find that the solution obtained with this restriction made still applies to the case in which the second winding is traversed by a current borrowed from the terminals of the machine; it is this modification of my original invention that has come into practical use under the name of *compound winding*. This being understood, the intensity of the current is shown by the expression

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* *Comptes Rendus.*

$$\text{I} = \frac{\text{E}_0 - \text{E}_1}{\text{R}} = \frac{\text{V}_0 f_0(\text{I}) - \text{V}_1 f_1(\text{I})}{\text{R}}, \qquad (1)$$

whence we get

$$\text{V}_1 = \frac{\text{V}_0 f_0(\text{I}) - \text{R I}}{f_1(\text{I})}. \qquad (2)$$

This equation shows the speed of the receiver as a function of the intensity of the current. Now this intensity is connected with that of the couple developed by the ring of the receiver by the relation

$$\text{F}_1 = \frac{\text{I} f_1(\text{I})}{g}, \qquad (3)$$

in which F expresses in kilogrammes the effort developed by the ring at the end of a lever arm equal to unity, the speed, V_1, of the ring being then equal to the number of metres traversed by the extremity of this lever arm in the unit of time. This relation enables us to construct easily, by means of the characteristic, the curve of the intensities as the function of the mechanical efforts, and, consequently, by means of equation (2) to find the speed of the receiver as a function of F_1. Let us now endeavour to find under what conditions the speed, V_1, may be maintained constant, *i.e.*, independent of the quantity of motive work that the receiver may have to develop during one revolution. Of course we suppose the generator to be animated by a constant speed due to the employment of regulators of speed acting upon the motor which works it.

The complete discussion of equation 2 would require that we should know exactly the analytical form of the functions $f_0(\text{I})$ and $f_1(\text{I})$, *i.e.*, of the characteristics of the two machines. We may with advantage replace it by a geometrical discussion resting on graphic constructions when we have the curves themselves; this process led me in 1881 to the invention of the double winding, to which I shall refer in a subsequent communication.

For the present, I shall confine myself to studying what happens when the intensity of the current is comprised within limits for which we are justified in considering $f_0(\text{I})$ and $f_1(\text{I})$ as linear functions of I, the characteristic then becoming a straight line. We then take

$$\text{E}_0 = \text{V}_0(a_0 + b_0 \text{I}), \qquad \text{E}_1 = \text{V}_1(a_1 + b_1 \text{I}).$$

Equation 2 then becomes

$$\text{V}_1 = \frac{a_0 \text{V}_0 + (b_0 \text{V}_0 - \text{R})\,\text{I}}{a_1 + b_1 \text{I}}.$$

In order that the value of V may be independent of I, *i.e.*, of F_1, which is the end in view, it is sufficient that we have

$$\frac{a_0 \text{V}_0}{a_1} = \frac{b_0 \text{V}_0 - \text{R}}{b_1},$$

whence

$$\text{V}_0 = \frac{a_1 \text{R}}{a_1 b_0 - a_0 b_1} \text{ and } \text{V}_1 = \frac{a_0}{a_1}\text{V}_0.$$

This expression is very remarkable, it shows that *whatever may be the values and signs of the coefficients,* a_0, b_0, a_1 (which are constants of construction), b_1, *and also the value of* R, *we can always solve the proposed problem by imparting to the generator a speed which only depends on these coefficients.* It is the same with V_1, the value of which is then

$$\text{V}_1 = \frac{a_0}{a_1}\text{V}_0.$$

We will now examine some special cases. Let us suppose, first, that the inductors of the two machines are furnished with a simple winding placed in series in the principal circuit and traversed by the general current. We get then

$$a_0 = 0, \qquad a_1 = 0,$$

whence it follows that the value of V_0 is indefinite. Thus, in this case, the problem is always solved whatever may be the speed of the generator.

The speeds, V_0 and V_1, are then connected by the equation

$$\text{V}_1 = \frac{b_0 \text{V}_0 - \text{R}}{b_1};$$

if the machines are identical this relation may be placed under the form

$$\text{V}_0 - \text{V}_1 = \frac{\text{R}}{b_0}.$$

Second case.—The receiver has a constant magnetic field.

We get then $\qquad b_1 = 0,$

$$\text{V}_0 = \frac{\text{R}}{b_0}, \qquad \text{V}_1 = \frac{a_0 \text{R}}{a_1 b_0}.$$

These equations can only be satisfied on condition that neither a_0 nor b_0 should be *nil*. The generator must then, in this case, be a double wound one.

Third case.—The field of the generator is constant. Consequently, we get

$$b_0 = 0,$$

whence

$$\text{V}_0 = \frac{a_1 \text{R}}{a_0 b_1}, \qquad \text{V}_1 = -\frac{\text{R}}{b_1}$$

a_0 and a_1 being positive, b_1 must be negative, that is, the magnetic field of the receiver must diminish when I increases. This is the case that I treated several years ago, when I endeavoured to find what conditions would satisfy a receiver in order that its speed might be independent of the resisting couple when the difference of potential at terminals was maintained constant (see *Comptes Rendus*, Vol. CI., pp. 1,128 and 1,162).

To sum up, we see that, with two machines the inductors of which are furnished with any windings whatever, the problem proposed can always be solved, with the exception of the single case in which the magnetic fields of the two machines would be constant, as is easy to see.*

When the function $f_0(\text{I})$ is given graphically by the characteristic, it is very easy to construct the characteristic that the receiver should have in order to obtain a speed independent of I. From equation 1 we get

$$f_1(\text{I}) = \frac{\text{V}_0 f_0(\text{I}) - \text{R I}}{\text{V}_1}.$$

But $\text{V}_0 f_0(\text{I})$ is the ordinate of the characteristic of the generator at the speed V_0, R I is the ordinate of the straight line $y = \text{R I}$; it is sufficient then for each value of I, to cut off these two ordinates one from the other in order to obtain as many ordinates as required from the characteristic that the receiver should have in order to turn at the constant speed, V, whatever I may be.

Supposing $f_0(\text{I})$ to be represented by a straight line, we can very easily arrive at all the conclusions that we have drawn analytically from equation 2. Now we can, in practice, come very near to this hypothesis on condition that the magnetic flux in the interior of the iron of the rings and inductors does not exceed the value of 6,000 C.G.S. units.

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* In this case the speed, v, of the receiver and the resisting couple, f, which it has to overcome are connected by the equation $\frac{f}{\text{F}} + \frac{v}{\text{V}} = 1$, which I demonstrated some time ago, and in which F and V are constants very easy to define.

In the case in which it is desired to obtain a constant speed of the receiver, while working with magnetic fields near saturation point, we must act upon the value of R by introducing into the circuit of the ring of the receiver a rheostat set in motion by a regulator worked by centrifugal force.

Tho rough rendering which has for its value $\frac{E_1}{E_0}$ would then be constant and independent of the resistances introduced, as I indicated long ago.

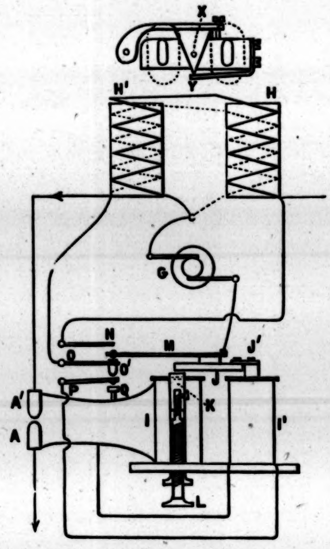
Excitation of the inductors in the case in which high tension machines are used.—In high tension machines intended to transmit power to long distances, it is of the highest importance to ensure by every possible means the insulation of the different parts of the machine when they are at widely different potentials and also to insulate them from the earth. We must then reduce to a minimum the number of organs in which the potential can be very different from that of the earth; hence the suppression of the excitation of the inductors by the current itself or by a derivation taken at the terminals of the machine, and the employment of a special exciting machine of low tension or of accumulators, such as I used in the Creil experiment (see M. Maurice Lévy's report, *Comptes Rendus*, Vol. CIII., p. 314). When a special exciter is used and not accumulators, the starting of the receiver requires a particular apparatus, which I have called a *liberating commutator*, the mode of action of which is this: in the first place, it enables the line current to pass through the inductors in order to create the initial magnetic field necessary, in order that the liberating of the receiver may be effected. This first result being attained (some seconds are required for this), the commutator is turned and brought into a new position, in which the communication between the line and the inductors is broken, while these latter are put into connection with the exciter set in motion by the receiver itself, the rotation of which may thus continue indefinitely. Thanks to this contrivance, the inductors are only brought to a high potential during a very short time, but it seems to have the effect of depriving the machine of all the properties resulting from the employment of an exciting winding, traversed by the general current, which have served as a basis for the reasoning set forth at the beginning of this note. I am going to show that this is not the case, and that although excited separately, the receiver may act exactly as if its inductors were traversed by the current of the line. For this it is sufficient that the inductors of the exciter should be traversed not by the current of this machine itself, but by the current of the line at high tension. If we calculate the number of spirals of the inductors of the exciter and of the inductors of the receiver, we shall obtain in the latter a characteristic of the same form as that of the exciter, *i.e.*, that within very wide limits the electromotive force of the receiver will be in proportion to the current passing through its ring, although its inductors are excited separately by a low tension current. The advantage of this arrangement consists in that the high tension current only passes through the small inductors of an exciting machine, which, being feeble in power and small in volume, may easily be perfectly insulated from the soil. We may, then, thanks to this process, apply all that has been said above to the high tension machines excited separately.

Electric Treatment of Aluminium. — The Société Electro-Metallurgique, a new French Company, has erected works at Froges, Iséres, France, in order to manufacture aluminium by the Heroult process, which is of Swiss origin. Current will be supplied by two dynamos, each of 7,000 ampères and 20 volts. Motive power is derived from two turbines of 300 H.P. It is estimated that the daily output of the works will be 3 tons.

MAQUAIRE'S ARC LAMP.

IN Maquaire's patent "Alpha" arc lamp the power necessary for striking the arc and regulating the feed of the carbons is supplied by a small reversing motor, the armature of which, placed vertically in the lamp between the field magnets, gears by means of a worm on the shaft with a large wheel, the pinion of which drives the upper carbon holder by a rack, so that a revolution in either direction of the armature causes corresponding and almost imperceptible motions of the upper carbon.

The lower extremity of the armature shaft is pivotted in a movable V-shaped yoke, X, which, when the lamp is working, is attracted by the field magnets and thus closes the magnetic circuit, at the same time throwing the worm into gear with the wheel. When the lamp is not working, the movable yoke is pushed back by a spring, Y, the worm being thus released from the wheel, the rack falls and the carbons, A, A^1, come together.

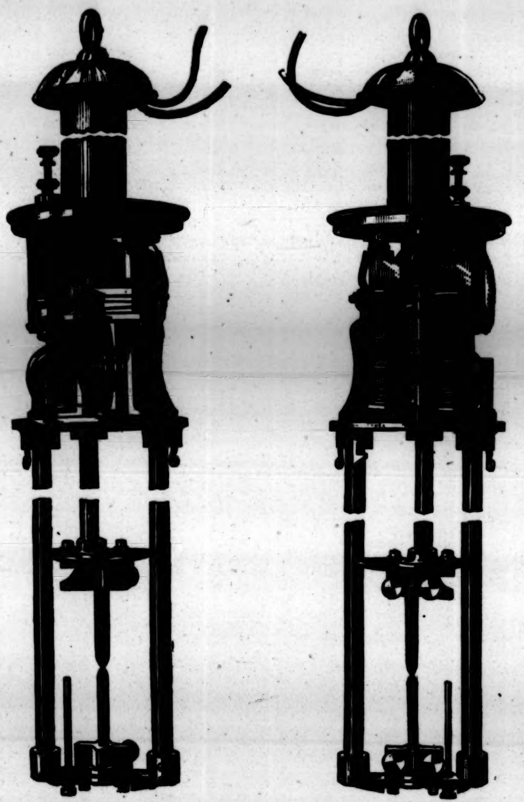


The field magnet coils, H, H^1, of the motor are in series with the arc, the armature, G, being coupled as a shunt on the field coils. The direction and duration of the armature current depends on the position between two contact pieces, N, O, of the movable lever, M, one end of which is held by a flat spring, J^1, the other end being free to move. A portion, J, of the lever, M, is of iron and is controlled by an electro-magnet wound with a coil of high resistance, I, coupled as a shunt on the arc, having a movable iron core which is adjusted by the screw, L.

In the event of the resistance of the arc increasing to too great an extent the shunt coil pulls strongly on the lever, M, causing it to press together, by means of the insulating stud, O^1, the contact points, P, Q, thereby short circuiting the arc through the coil, I^1, which increases the pull on the lever and ensures good contact between P and Q.

The lamp may be made to strike any desired length of arc and feed at any potential by altering the position of the contacts, N, O. The potential on the armature of the motor is 2 volts. As, during the time the lamp is in action, the carbons can only move under the action of the motor perfectly steady burning is ensured, more especially as the shunt coil has only to alter the position of the lever; so that any accidental friction in the lamp does not in any way affect the feeding point.

Lamps of this description have been burning for some time past at Kensington, two in series on the 100 volt incandescent circuit, and have given every satisfaction.



MAQUAIRE'S ARC LAMP.

These lamps, which are also made focussing or double carbon, are constructed by the Planet Electrical Engineering Company, Limited.

NOTE ON THE RECALESENCE OF IRON.

By ELIHU THOMSON.

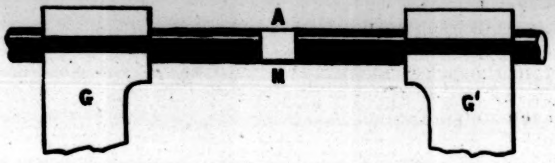
IN the ELECTRICAL REVIEW of March 29th, 1889, I notice a very interesting paper by Dr. J. Hopkinson, on the recalesence of iron. The very interesting phenomena there recorded belong, without doubt, to the same class as some phenomena which I have repeatedly noticed in welding steel bars by electricity.

When two bars of tool steel are abutted in the welding clamps and the current is turned on so as to gradually heat the bars to redness, there is noticed a sudden brightening after the bar has passed through the dull red stage and a rather sharp line of demarcation between the brightened and the duller metal nearer the clamps may be seen. This line moves in each of the two pieces from the joint outward towards the clamps, marking the spread laterally from the proposed joint of a zone of increased temperature pretty sharply defined from the metal of the lower temperature on each side of it. Similar and reversed phenomena has sometimes been noticed in the cooling of the pieces.

I was at first disposed to attribute the phenomena, during the heating by the current, to a critical point of resistance, after passing which the resistance curve or temperature coefficient took a sudden lurch, but the observations of Dr. Hopkinson seem to me to be sufficient to explain the phenomena, at least in part, though it is not impossible that at the temperature of recalesence there may exist also a critical change in electrical resistance, which may add its effects in producing the phenomena noticed during the heating by the current.

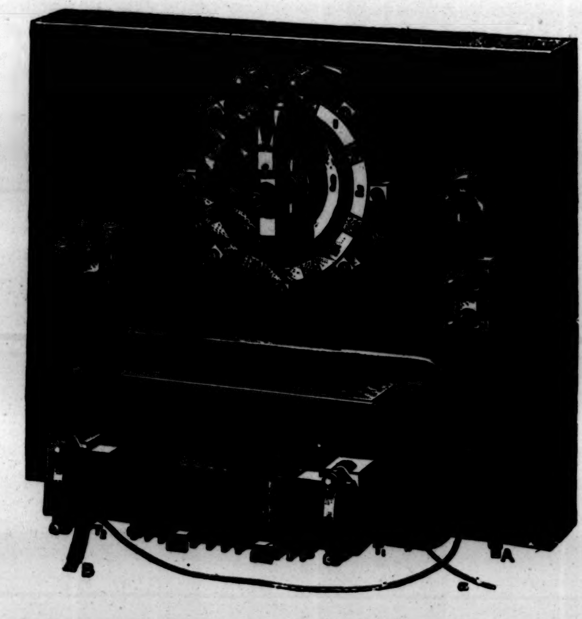
I have not noticed this effect in soft iron or in other metals, hard tool steel being the only one which appears to give it, so far as any observations have been made by me. During the heating of the steel by the current there is, as Dr. John Hopkinson explains in connection with his observation of an ascending curve of temperature, an absorption of heat at the point of recalesence, which point being passed the temperature rises quite rapidly. This gives the effect which I have stated, *i.e.*, the sharply defined zone of higher temperature spreading laterally from the joint during the heating operation.

I have noticed the same phenomena in the heating of a complete steel bar between the welding clamps without forming a joint, there suddenly appearing at a middle point between the clamps a zone of high temperature, rather sharply defined from the cooler and less luminous metal around it, which gradually spreads towards the clamps. This I have attempted to indicate in the figure sent herewith, where the steel bar, A, is being heated between the clamps, C, C′, by the passage of a heavy electric current. After passing a dull red a much brighter zone appears at the middle, M, and expands along the bar. Of course it is impossible to check the heating so as to prevent this zone from spreading, because the conductibility of the metal for heat itself would in a few seconds merge the heated zone with the adjacent cooler portions of the bar and therefore the line of demarcation is more noticeable or decided the quicker the heating action progresses.



THE KAPP REGULATING TRANSFORMER.

AMONGST the various advantages possessed by the system of alternating current distribution is that of facility of regulation. With an alternating current supply on the feeder system, says *Industries*, constant pressure at the feeding points, at all times and for all loads, can be obtained by the insertion of a small transformer into each feeder, which raises the pressure at the station end of the feeder by the exact amount which is lost on the way in consequence of the ohmic resistance of the feeder. The primary coil of the regulating transformer is connected with the terminals of the dynamo, and the secondary coil is sub-divided into a number of sections connected with a multiple contact switch. The current flowing to the feeder is led by means of this switch through one, two, or more of the sections of the secondary coil, and receives there an additional E.M.F. proportional to the number of sections inserted. The regulating transformer is so proportioned that, when the whole of its secondary coil is inserted, the increase of pressure is just sufficient to make up for the loss due to the ohmic resistance of the feeder. If the current flowing out is below the maximum, the switch is set to some intermediate point, so that in all cases the pressure at the distant feeding end is kept constant. This principle of regulation, which has been devised by Mr. Gisbert Kapp, primarily with a view to its application in central station work, is also suitable for regulating the pressure on the lamp circuit in private installations. In the particular case of the transformer here illustrated, and which was made for Sir David Salomons, it was desired to have means for either raising or lowering the pressure in the lamp circuit, and the secondary coil of the transformer has therefore been divided into seven sections, five of which are traversed by the lighting current in one direction, and are used for raising the pressure, whilst the remaining two are traversed in the opposite direction, and are used for lowering the pressure. The switch has accordingly seven contacts. When the handle is in the position shown in the diagram, the whole of the secondary coil is cut out, and the pressure supplied to the lamps is that given by the secondary coil of the main transformer, which serves this installation. If the switch handle be moved to the right over the contact marked I, the current in the lamp circuit is caused to flow through one of the opposing sections of the secondary coil, and the available pressure at the lamps is reduced by 2 volts. If the switch handle be further moved to the right over contact 2, the second section is brought into circuit, and the E.M.F. is reduced by 4 volts. On the other hand, if the switch handle be moved to the left, those sections of the secondary coil in which the E.M.F. is additive are successively brought into circuit, each step adding 2 volts to the available pressure at the lamps, so that by moving the switch handle round to the contact marked 5 an increase of 10 volts over the pressure given by the main transformer is obtained. The connections are as follow :—The service leads from the main transformer are brought to two terminals, to which the main lamp circuit is connected. Into one branch is inserted the regulating transformer, connection being made with the cables, A and P. One terminal, T_1, of the primary coil of the regulating transformer is connected with one of the main terminals of the supply circuit, and the other terminal, T_2, is connected by means of the switch, *s*, and wire, *b*, with the cable, P, coming from the other main terminal. The switch, *s*, is inserted so that the primary can be cut off if the instrument is not required. The cable, P, is connected by a fuse and lead, B, with the inner contact, C, of the multiple contact switch, S, and the cable, A, is similarly connected with the middle or zero contact of the switch by the lead, D. The other contacts of the switch are connected with the different sections of the secondary coil in the manner already explained. The advantage of this regulating apparatus is that without appreciable loss of energy, and by merely setting the switch to one or other of the contacts, the brilliancy of the lamps throughout the whole house can be regulated, whilst the regulating power is the same whether only a few lamps or the whole of the lamps in the house are alight. With the apparatus above described, the increase or diminution of pressure is, however, quite independent of the number of lamps in use, and the consumer is able to burn his lamps with either a higher or lower voltage than that supplied from the central station.



Sir David has suggested the following improvements which are being carried out, and he also points to some advantages for a private house arrangement :—

1. In general leads are made (parallel system) far larger than necessary to keep the light fairly equal for any number of lights in use. By using this transformer regulator there is evidently no necessity for this, and consequently a great economy in first cost of mains.

2. On ordinary occasions the lamps may be "burnt low" so as to increase their life, for the loss of light and efficiency is nothing compared with continual demands for replacing lamps. Carrying of ladders, steps, &c., does damage and is inconvenient, for lamp breakages, like breakdowns, take place, generally when not wanted.

3. On "red letter days" the light may be raised if desired.

4. At present, on the London Electric Supply Corporation's circuit, Sir David gets for many hours only 87 volts, and later in the evening often as much as 105. This he could not put up with, hence this apparatus was inserted. He hopes, when the Deptford station is working, matters will improve, but even if a constant standard 100 volts is given this instrument will be very convenient.

5. With this regulator one danger exists. If, when the pressure is low, the volts are raised at the station, and suddenly the change of pressure to 105 volts occurs, all the lamps in use will be broken or injured, so he is having a device made which shall cut out the fine wire circuit on the transformer as soon as 100 volts is reached ; thus perfect security will exist.

6. With a slight alteration, Sir David's counter E.M.F. governor would work the switch automatically for constant pressure.

7. He is having a switch made with two fingers and an impedance coil, or a resistance (not decided yet which it shall be,) between, to avoid sparking, when moving the handle, also a very simple snap action, to set the finger to its place automatically, and an arrangement by which the fine wire circuit is cut, when the switch finger stands at zero ; thus a continual passage of 1 to 1½ ampères is avoided when no work has to be done.

8. The switch to cut the fine wire is now D.P., also a reverser to make a 10 volt fall and 4 volt rise if required instead of the reverse. The London Electric Supply Corporation ought to welcome the use of these apparatus, for it will produce satisfaction to the customers, if only the "everlasting" breakdowns could be avoided. There have been very many of them lately.

BARBER-STARKEY'S SEMI-INVERTIBLE AND PLUNGER CELLS.

THE object of the semi-invertible cell is to enable the exciting liquid to be removed from the elements without withdrawing the latter by hand ; this is effected by canting over the whole cell through an angle of 90°, the change of position been effected by holding the cell by either of two handles. The way in which this effects the required object is as follows :—The elements are placed along one side of the battery or cell. When these elements hang vertically they are in the solution, and the cell is consequently in action, but when the cell is turned through a quarter of a revolution and held by the handle which is attached to the side which is parallel to the elements, they then lie in a horizontal position at the top of the cell, out of the liquid, and consequently the cell is out of action.

Figs. 1 and 2 show the arrangement. It will be seen that the tops of the elements to which the connections are made are in both positions of the cells clear of the liquid, as it is only necessary to have an opening at this part of the cell at which to insert the elements in the first place; *there is thus no joint covered by the liquid;* this is the great point of novelty in the invention and is a decidedly ingenious and novel idea. Another equally important point is that a small pin hole can be left in the cover to allow of the escape of any gas which may be generated in the cell; and as the cover is never touched by the liquid, the latter cannot get out, whilst the gas can always freely escape. The cell itself, which has its opening closed by a watertight cover so as to prevent splashings from getting out, is made of an acid proof material and is preferably enclosed in a light wooden case, the whole apparatus (as arranged as a miner's lamp) having the appearance shown by fig. 3.

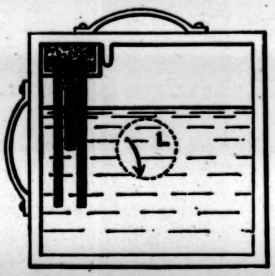


FIG. 1.

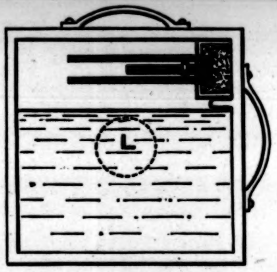


FIG. 2.

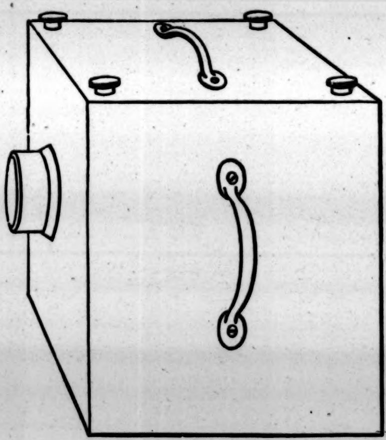


FIG. 3.

Another form of the cell, known as the "Plunger cell," is shown by figs. 4 and 5. This form of cell which is preferably made cylindrical, consists of a cylinder or containing vessel, the lower half of which is divided into the required number of separate cells by divisions of insulating material. In the upper half of this cylinder a piston or plunger is made to travel up and down. To this piston is attached a handle which slides up and down on the uprights to which the main handle of cell is fixed, so that the piston is always kept true; the handle of the piston is made hollow, and through it the wires are led up to the lamp, which is attached to one end of the sliding bar. At the other end a screw is fitted which holds the plunger in any desired position; this plunger is made hollow, the metals are placed in position and connections made, and then melted paraffin is poured in, which fills up the mould and makes a solid plunger filled with paraffin wax in which all the connections are embedded and effectually protected from injury. When it is required to re-charge the cell the main handle is removed, the plunger is withdrawn, when the exhausted liquid is poured out and fresh put in its place; and when it is required to renew the zinc, it is only necessary to unscrew the nut at the top of the plunger and the old zinc will drop out.

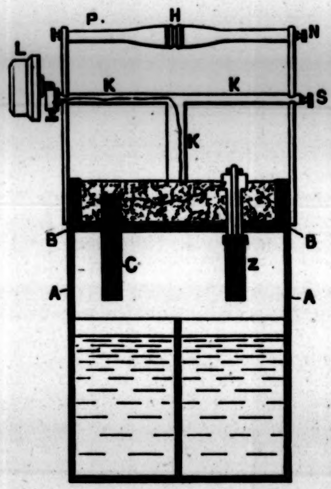


FIG. 4.

A = cell.
B = plunger containing the electrodes filled in with paraffin wax; represented by dotted space.
Z = zinc. C = carbon.
K = hollow handle of plunger, up which wires run to lamp.
L = lamp. P = metal pin which passes through handle, H.
N = nut to unscrew to withdraw pin. S = screw for holding plunger in position.

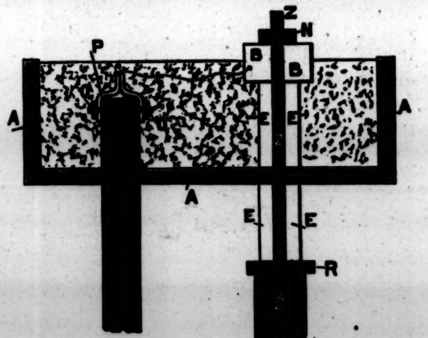


FIG. 5.

A, A, A = mould or hollow plunger, which is filled in with paraffin wax and in which the connections are embedded; dotted space denotes the wax.
Z = zinc rod with thin neck. E = ebonite tube.
B = brass block into which ebonite tube is screwed.
N = nut which screws on to zinc rod and presses against B, so making good connection.
R = rubber washer.
P = platinum foil pressed against carbon, C, by ebonite pin and nuts, O, O.

The plunger on piston has a rubber ring or band attached to it, to ensure it fitting accurately in the bore of the cell.

This cell is practically water-tight for ordinary purposes and is extremely simple and cheap to construct, and the depth of immersion of the zinc and carbon in the liquid can be exactly *regulated* by the screw.

In both forms of cell the connections are perfectly protected, and the solutions can be at once emptied and refilled and zincs renewed with the greatest ease by unskilled hands; they can also be cheaply constructed.

These cells are manufactured by Mr. F. Geere Howard, of Cleveland Works, Cleveland Street, who will also supply a cheap solution suitable for the cells. They will be made to light a lamp from three to twelve hours, according to the purpose for which they are required.

PROF. ELIHU THOMSON'S NEW METHOD OF REGULATING CURRENT OR POTENTIAL IN THE SECONDARIES OF TRANSFORMERS.*

IT is but a few years since the designing of electro-magnetic machinery, in the broad sense of the word, was more a matter of trial and error than of calculation; and although in the case of the dynamo good machines were developed from the process, it was not until the work of Hopkinson, Kapp and others on the construction of these machines appeared that dynamo building can be said to have been reduced to an accurate scientific basis.

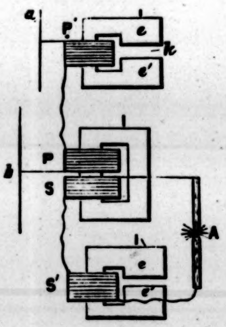
The principal factor which characterises the new method of dynamo construction is the treatment of the magnetic circuit in the same manner as the electric, so that the "resistance" of the magnetic circuit has come to be quite as important a consideration as the electric.

Without entering further into the importance of taking this factor into account, we desire to draw attention to a beautiful application, by Prof. Elihu Thomson, of the theory of magnetic resistance to the regulation of alternating current apparatus so that either constant potential or constant current can be maintained in the secondaries of transformers, independent of the external resistance of the circuits. While primarily designed for the purpose of maintaining constant alternating currents such as would be required for arc lamps, the method is applicable to other purposes, as will be described later. The regulation is effected by the direct action of the lines of magnetic force themselves, in concentrating or focussing themselves across a narrow non-magnetic space, forming a partial break in what would otherwise be a perfectly closed magnetic circuit for the magnetism developed by the current of the coil in question.

The method employed by Professor Thomson will be best understood by referring to the diagram, fig. 1. Here *a* and *b* are alternating current constant potential mains, the coil, P, being connected to them as a primary, S being the secondary, and both being wound on the same core. We will suppose that the number of turns in P or in any coil in circuit with it, as P′, is such that, having reference to the potential of *a*, *b*, very little current will pass in P when the circuit of S is open. P′ is an additional coil wound on an iron core, I, in which core the alternating currents will obviously produce an alternating magnetism, and if the core of this coil were continued around so as to be endless, there would be a magnetic circuit entirely closed and a maximum of reactive effect in the coil, P′, opposing the passage of current from *a* to *b*. Instead, however, of making the magnetic circuit completely closed, the core is provided with projections, *e*, *e′*, which are brought rather closely together, with, however, a determinate air-space between them, forming a partial break in the closure of the magnetic circuit for the magnetism developed by the current flowing from *a* to *b*. The space forms an air or magnetic resistance to the closure of the magnetic circuit for coils P′, and, as will be obvious, the more perfect the closure of the magnetic circuit at this variable point the greater will be the reaction upon the currents flowing from *a* to *b* through coils P′. During normal flow of currents from *a* to *b* there is a definite degree of closure of the magnetic circuit at *k*, dependent upon the width of the space and the number of magnetic lines of force which, with the given strength of magnetism in the core of P, may force themselves across the space. If there is any tendency to increase in the magnetism of the core of P′, the lines of force concentrate or mass themselves together in the space across *k* and become less diffused. By this means the degree of closure of the magnetic circuit of the core is increased and the reaction in coils P′ increased. This variation of partial magnetic closure or variation of magnetic resistance obviously takes place independently of the magnetic circuit formed by the core threading the coils S.

Leaving out of consideration the coil S′ in the circuit of S, the operation in regulating or adjusting the current in the circuit of secondary S is as follows: When there is a tendency to increase of current in the circuit of S, due to decrease of resistance, there is an attendant decrease in the counter electromotive force of the primary coil, P, as is well understood, and there would hence be a tendency to increase of flow in the coil, P; but with an increase of flow in the coils of P there is also an increase in the coils of P′, and an increase in the number of lines of magnetism which pass over the magnetic resistance at *k* is produced. Inasmuch as the reaction of the coil, P′, depends upon the amount of magnetic disturbance set up in its core or the number of lines passing from *e* to *e′*, it is obvious that the currents flowing from *a* to *b* will meet an increased self-inductive reaction, and the current on the secondary circuit, S, will be cut down.

FIG. 1.



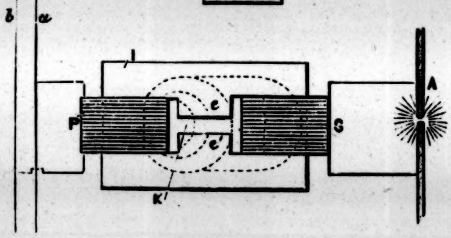


FIG. 2.

As the rate of variation of closure at *k* may be varied by any desired means, and may, in fact, be determined by the width of the space, *k*, it is obvious that the regulation or the adjustment of current in the circuit of S may be of any desired nature. The prime object is, however, to secure a practically constant current in the secondary circuit, and the width of the gap, *k*, is made such as to produce as near as may be that effect. The regulation of the current or potential in the secondary circuit might also be produced by variably closing a magnetic circuit developed by the secondary current and independently of the magnetic circuit of the primary current. Thus, as indicated at S′, the secondary current may pass through a coil which shall set up magnetic effects in a core having a partial magnetic closure of variable amount, as at *k*. In this case the same effect of a reduction in the current or potential of the secondary is produced by the variation in inductive reaction at the coil, S′, secured by variably closing the magnetic circuit of the core of S′ at *k*. The effects produced by the variation of magnetic closure of the core excited by the secondary current might obviously be used alone or in conjunction with similar effects produced in the primary, as at P.

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* *Electrical World.*

Instead of varying the magnetic closure of a core surrounded by a separate coil, as shown in fig. 1, the magnetic circuit for the portions of core of the coils P, S, themselves may be variably closed, each portion of core having its magnetism closed without passing through the other portion, as shown in the coil, figs. 2 and 3, which is the actual construction adopted. This is accomplished by means of projections, *e*, *e*′, extending from some part of the iron core or circuit which threads both the primary and secondary coils, the projections being separated from one another by a space, K, forming a magnetic resistance similar to the space, *k*, of fig. 1. By means of the variable magnetic resistance formed at K, the magnetism developed in the portion of core surrounded by the coil, P, is variably closed. In fact, the magnetism can work, as it were, through two magnetic circuits, one including the space or resistance, K, and the other including the portion of core passing through the coil, S. The magnetic lines developed by the core or coil, P, which pass through the air space at K, and escape the coil, S, produce wholly self-inductive effects, resulting in an opposition to the flow of the primary currents, while all the lines developed by the coil, P, which pass through the axis of the coil, S, result, as usual, in the production of secondary currents.

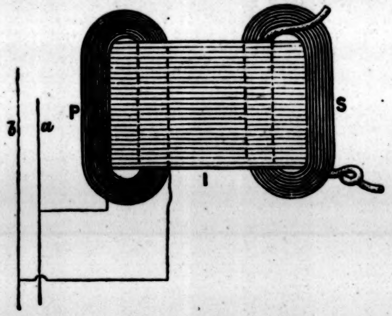
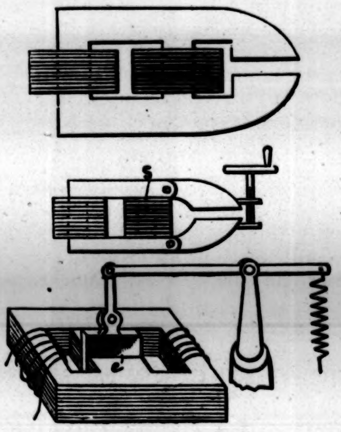


FIG. 3.

It will be readily seen that, as before described, any tendency to increase of the current flowing in coil, P, resulting from a lowering of the resistance in the circuit of S, will be at once followed by the development of increased magnetisation of the proportion of core in coil, P, by the formation of increased magnetic lines across the air space, while at the same time the self-induction of the coil, S, itself will undergo an increase, owing to the fact that a path of variable closure for the magnetism in the core is likewise formed across the space, K. In fact, the effect of a slight increase of current in the coil, S, would be to oppose the passage of the lines of force tending to pass through its coils from the coil, P, and cause them to be shunted across the space, K. The result of all this is that the varying resistance in the circuit of the secondary, S, would receive a current which tends to be limited in strength, and to be self-regulated through the provision of the variable magnetic resistance formed at the point, K′, on partial closure of the magnetic circuit for the cores of the coils. As will be observed, the effects and principle of operation are much the same as before explained in connection with fig. 1, excepting that the partially closed path here permits the added effect due to the beating back of the inducing magnetism in S, and in effect results in a shunting from S of the magnetism developed by coil, P.

In fig. 2, A represents an arc lamp, fed with constant current from the secondary, P, although the primary coil, S, is subject to constant potentials. If the distance between the projections, *e*, be properly determined, it will have the peculiar property of producing in the secondary coil, S, a droop or fall of electromotive force when the resistance is cut out of the circuit, and this fall may be made nearly proportionate to the fall of the resistance, or diminishing resistance, in the circuit, thus maintaining the current constant.

The partial closure of the magnetic circuit of the core, I, may be produced outside of both coils, P, S, instead of between them, as shown in fig. 4. Other methods, such as illustrated in figs. 5 and 6, may also be employed, and a variety of others which will readily suggest themselves.

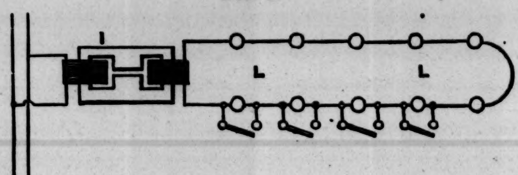


FIGS. 4, 5, 6.

The full line, fig. 7, illustrates what may be called the "characteristic curve" of the secondary currents in such a coil as fig. 2, the verticals or ordinates representing the electromotive forces evolved, and the horizontals or abscissæ the current strengths corresponding thereto. At electromotive forces below 100, as shown, the curve is almost a vertical line, showing that a constant current is evolved at any resistance below that corresponding to a potential of 100. The dotted curve represents the case of drooping or falling potential with increase of current, such as is obtained

FIG. 7.

FIG. 8.



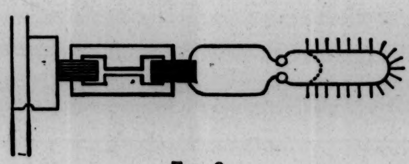


FIG. 9.

with some special arrangements, such as that shown in fig. 1.

While, as stated above, the method is applicable primarily to the operation of arc lamps on constant potential alternating circuits, it has a variety of other uses. Thus it may be employed to maintain constant current in a number of incandescent lamps placed in series, as shown in fig. 8, any one or all of which may be switched out of circuit without danger. Another application is the maintenance of a wire at uniform heat independent of the length in circuit, as shown in fig. 9. Still another is the use of the method for maintaining a constant current in electric furnaces which, as is well known, are liable to sudden and great fluctuations in current, and thus are a constant menace to the dynamo feeding them. Other applications will readily suggest themselves, but enough have been mentioned to indicate the wide scope of Prof. Thomson's method of alternate current regulation.

ALTERNATING CURRENT MOTORS.

WE have received from Messrs. Ganz & Co., of Budapest, a communication on the latest results which have been obtained with alternating current motors since the electricians to this firm, Messrs. Zipernowski, Déri and Bláthy, have been engaged for four years in experiments on various forms and types of such apparatus :—

Turns per minute.	Performance of motor.		Energy apparently consumed.	Effective energy consumed.		Ratio of Watts actually consumed to apparent volt-ampères.	Effective useful effect per cent.
	H.P.	Watts.	Volt-ampères.	Watts.	H.P.		
600	15	11·000	18·000	15·800	21·5	0·88	77·
700	19·8	14·600	24·200	18·600	25·2	0·77	78·5
730	30·7	22·700	29·800	27·700	37·6	0·92	80·9

The circumstance that the apparatus used for these experiments was a model constructed for the purpose of study, in which the attainment of the greatest useful effect was not the main object, but rather the experiments with it were to show how the greatest useful effect can be obtained; and, secondly, that the motor in the experiments was not working with its normal number of rotations of 750 per minute, but at a lesser speed justify the assumption that in this manner as good a useful effect of the power transferred can be obtained as with the best continuous current motors.

A very important result lies in those figures of the above table, which show that the proportion between the apparent (*i.e.*, ascertained by means of the voltmeter and ammeter) volt-ampères, and the watts actually determined by a watt-meter, which the motor consumed, approach unity; because therein is a condition fulfilled which has hitherto been sought in vain.

The distribution of the current by means of an alternating current has gained a continually increasing extension—thanks to the transformers—but hitherto it has been rationally available only for the production of light.

The problem of the electric transmission of power by alternating currents involves various difficulties. In the first place the efficiency of alternate current motors has been a long way behind that of the continuous current motor. Secondly, with certain types constant speed regulation was found impossible; thus, if a motor satisfied the requirements in one direction, it was unfit for purposes where variable power was desired. Thus it happened that when such a motor was, for instance, receiving 5,000 watts from a 100 volt circuit, it did not use 50 ampères but 150 and more; that is, the motor appeared to consume three times the energy that seemed necessary. This was a great drawback to the employment of alternate current motors, for the cables had to be made several times as large as was necessary with continuous current motors. The generating plant and transformers also had to be made proportionately larger, consequently the existing apparatus, if it had to be utilised for the transmission of power, was found insufficient for the purpose. This was a disadvantage which the advocates of the continuous current system were justified in urging against the alternating current motor.

A solution of the problem was hoped for when Prof. Ferraris published his ingenious experiments, and when soon afterwards Tesla and others made practical use of the already indicated results. Unfortunately in all these systems there are at least three conducting wires requisite, and they require either generators of a special construction, or else two separate machines coupled at a suitable angle.

In how far it has been found possible to remove the above-mentioned disadvantages with alternate current machines we are unable to say, since very little has as yet been published thereon.

A paper in No. 589 of the ELECTRICAL REVIEW of March 8th of the current year on "Alternate Current Motors," shows, on the contrary, that quite recently we were very far distant from being able to show satisfactory results. This communication sums up the opinion which had been formed from previous results :—

"We know also that this alternating current motor requires for its action two independent circuits. We likewise learn from the remarks during the American Institute in May last that the number of rotations of the motor falls when the load is increased. Herr Tesla says that this must be ascribed to the circumstance that the armature had to develop a considerable power when set in motion. If, on the contrary, we produce an armature merely for synchronism the speed will always be the same, however great the load may be; but one disadvantage here is that the rotary effort is so small that the motor cannot set itself in movement.

"The weight of the material which is expended in a Tesla motor is several times greater than that which is requisite in a continuous current motor for the same duty, which makes the machine in question exceedingly costly. It therefore appears that the alternating current motors are still far removed from the ideal, in spite of the exertions of one of the most capable nations in the world, and we venture to express the opinion that the solution of the problem must be sought for in a quite different direction."

The electricians of Messrs. Ganz & Co. have endeavoured to work out the problem in a different direction, and they appear to have obtained successful results. Their own communications point to the fact that they are fully satisfied, and they consider the solution of the problem as complete. According to their own calculations, alternate current motors now in course of construction at Messrs. Ganz & Co.'s works are expected to give a commercial efficiency of 90 per cent. Since the proportion between the apparent and the actual watts is approximately unity, therefore the comparison between this motor and continuous current motors must hold good, and they expect corresponding results.

We will further point out some peculiarities of the alternating current motor, which are said to confirm its superiority to the continuous current motor.

1. The easy and certain power of regulation, *i.e.*, constant speed with different loads within its working limits.

2. That the high tension current has never to pass through the commutator, since it is possible to bring the alternating current into direct connection with the terminals of the motor and with the fixed armature, whereby the application of far higher tensions in a machine becomes possible, so that it can be more economically effected than in a continuous current motor.

3. The possibility of the distribution of power at greater distances. For although we have already succeeded in setting large continuous current machines in action at great distances with a good result, the size of these motors was still decidedly limited, since it was

not economical to construct small continuous current motors for high tensions, and also because with such small apparatus, if they have to receive a current of high tension, no certainty in working is conceivable. On the contrary, small alternating current motors can be worked economically and safely by means of a current of low tension converted in the transformers.

Lastly, 4. In alternating current machines the insertion of additional resistances is dispensed with, as the self-induction existing in the motor takes their place, which contributes essentially to the simplification of the entire installation.

The production of a good practical alternating current motor is, in fact, the solution of the most important problem of the distribution of power from central stations.

ELECTRIC LIGHT PROVISIONAL ORDERS.

BOARD OF TRADE INQUIRY.

(*Continued from page* 450.)

ON Wednesday, April 17th, the enquiry was resumed before Major MARINDIN at the Westminster Town Hall.

Mr. RUSSELL GRIFFITHS, in opening the evidence on behalf of the case for the City of London, called

Mr. HENRY BLAKE, the chief clerk to the Commissioners of Sewers. He said that since 1878 various works had been carried out in the City in electric lighting, and during six years close upon £12,500 had been expended. In most of the contracts entered into there were provisions for both private and public lighting. In 1882 a contract for public lighting in the neighbourhood of Holborn Viaduct was made with the Edison Company, and certain existing subways were to have been used. Lately there had been negotiations with the Brush Electric Lighting Company, with regard to which Colonel Heywood had drawn up a report. He had seen the streets opened in the City for the purpose of gas lighting, water supply, and other purposes, and he judged from his knowledge of the condition of the streets that, supposing there were two electric lighting companies endeavouring to lay down mains, there would be great difficulty in regard to the opening up of the streets.

Replying to Mr. PEMBER, Q.C., the witness said that clauses were inserted in the specification attached to the contract alluded to with the object of avoiding the double laying of mains. Possibly the clauses were intended to preclude competition from the City area. He was aware that in Parliament the question of competition between electric light companies was discussed, and he believed it was left an open question for the Board of Trade. Parliament had also considered the question of the price to be charged and the duration of the life of the companies. By the Act of 1888 the limitation of 21 years had been extended to 42 years, but the limitation of 21 years did not interfere with the provisions of private lighting.

Mr. W. H. PREECE, chief electrician to the General Post Office, stated that he had been associated for purposes of consultation on questions of electricity with the City Commissioners of Sewers since 1882. There were 24,893 inhabited houses within the City radius, according to the census of 1881, and a residential population of 261,061. About 800,000 entered the City every day. There were a great many places in the City which would require artificial light during the day as well as by night. He estimated the number of gas burners used for private and ordinary purposes at 622,000, and the average consumption of each burner was 5 feet per hour. There were 3,136 public lamps, which cost the City £10,530 per annum. The great bulk of light for private purposes in the City would be required up to about 7 o'clock. There were also, however, printing and other works which burnt light all night, and a great deal of light was required during the night. It was extremely difficult to form an accurate estimate of the number of hours of lighting in a place like the City. The only case from which a conclusion could be drawn was that of the central station in New York started by the Edison Company in the neighbourhood of Wall Street—a district somewhat similar to the City. The average number of hours per lamp per day during which light was consumed in New York worked out at 2·4 hours per day, or 876 hours per annum; and that was a fair estimate of the amount of lighting in offices, restaurants, &c., required in the City. In New York the latitude was 41, and in London 52, and that difference of latitude would add about an hour's difference in the average length of lighting in the City of London. That gave an average in London of 3·5 hours. He doubted whether it was fair to draw any comparison whatever between the private lighting of a business quarter like the City and the private lighting of residential places like Kensington and Wimbledon. In a bank or in a club nearly all the lights were lighted at once, but in a private house a number of lamps were only lighted for a short time. He had read the evidence of Mr. Crompton as to the demand for the light in the West End. Mr. Crompton said that the chief demand in the City was from 5 to 7 o'clock. If one company had to supply the residential portion of the West End, and the shops and theatres, and also to meet the demands of the City between 5 and 7, he believed the demands of the two places would overlap. The consequences of overlapping would depend upon the plant. If the electric light was dependent upon running machinery without any storage, there would be great difficulty in providing the double light, and additional machinery would have to be provided which would have to stand idle until the time came for the great pressure. Machinery running what was termed "light" (*i.e.*, at less than its full power) always ran uneconomically. In the City there were 46 miles of streets, so that if double mains were laid, 92 miles of mains would have to be put in, and, if there were two competing companies, 184 miles of mains. Excluding courts and alleys, there were 33¼ miles. To replace the existing gas lamps, 500 arc lamps and 1,000 glow or incandescent lamps would be required. The latter would be of 25 or 32 candle-power, and their size would depend upon the space over which the lamps would show. For private lighting about 210,000 10 candle-power lamps would be required—that was to say, about one-third of the existing 622,000 gas lamps. That would be 70,000 lamps for each of the three districts into which the City had been divided. The General Post Office was partially lighted by electricity, and it had its own installation, which had been put up under his superintendence and advice. The cost per Board of Trade unit of lighting the Post Office was 3½d.; but the engines used at present were not the most economical, and with more modern machinery he believed the cost could be reduced to 2½d. There were great numbers of private electric lighting installations in the City, including the Union Bank of Australia, the Union Bank of London, the National Provincial Bank, the Bank of England, Lloyd's, Winchester House, and several newspaper offices. He had been consulted as to certain specifications which the City authorities proposed to issue, and he quite approved of the proposed conditions contained in them. He had considered the scheme proposed by the London Electric Supply Corporation for the transmission of electricity at a very high pressure from Deptford to London—a gigantic experiment. Generally he was a decided advocate of the distribution of electricity over extended districts by alternate currents. There was almost as much to be said in favour of one large station down the river as there was in favour of several stations spread over a district, and his strong objection to the scheme of the London Electric Supply Corporation was not the question of several stations, which could be perfectly worked out, but the connection between Deptford and London by means of mains. He would say emphatically that he regarded that part of the proposal as very objectionable indeed. He had heard the evidence of Lord Crawford and of Mr. Ferranti as to the dynamo driving with 10,000 horse-power, and he considered that it was possible not only to have a dynamo of 10,000 horse-power, but to make engines and dynamos of 20,000 horse-power. In transporting the converted energy from Deptford to London, he anticipated great difficulties. There were difficulties of insulation, difficulties of joints, and, above all, difficulties of disturbance of telephones and telegraphs. There was no difficulty in connecting supply electric lines with distributing mains, which were to be the same as the trunk mains. The difficulty was simply in the connection between the dynamos and the large transformer at the distributing station in London. He had not seen a motor which could be applied to the alternating system. Two or three were spoken of as being in existence, but they had not yet been produced. An American invention had been spoken of a good deal, but it was not in the market yet. There were motors for using the energy supplied by the direct system. There would, in his opinion, be a very large demand in the City for motive power supplied by electricity, and that would be a remunerative source of income to the electric light companies. The main reason which controlled the Commissioners of Sewers in recommending the sub-division of the City into three districts was that they were giving the public the benefit of competition, while the City authorities themselves would be prevented from suffering from the very greatest of all inconveniences of competition—the cutting up of the streets by rival companies. The main streets of the City, taking Holborn, Newgate Street, Cheapside, and Fleet Street as instances, were at the present moment completely choked. The Post Office had in Cheapside from 15 to 20 different pipes of its own, and it would be almost impossible at the present time to lay a new 6-inch main down that thoroughfare. One objection to competition was that if there were two companies passing down one street there were double mains, double plant, and double capital, and sooner or later the competition led to amalgamation. That led to an enhanced price to the public, and so in the end the public had to pay. On the other hand, competition, or the fear of competition, secured splendid services, and he was convinced that the proposed system would obtain a good supply. "Potential competition" was a very excellent term, and was just the sort of competition the City authorities were anxious to see. There would be especial danger of leakage with the rigid mains, and here he should like to draw a distinction between danger to persons and danger to telephones and telegraphs. As regarded danger to persons, no more effective mode of mains could be suggested than that proposed by Mr. Ferranti, but the difficulty was that the telephones of London would suffer. With a 10,000 volt current, and the original main as proposed by Mr. Ferranti, there was not a single telephone in London which would not be disturbed by the alternating currents from Deptford. The proposed *maximum* unit of price was 8d., and he anticipated, in the progress of electrical knowledge, that electric energy would in the future be produced at a much less cost.

In cross-examination the witness said that, even if a direct line from Deptford could be got, there would still be a considerable disturbance of telephones. He had discussed this matter in a perfectly friendly way with Lord Crawford and Mr. Ferranti, who were desirous of meeting the objections of the Post Office, and were not wedded to this particular form of main. The amount of insulation necessary to meet the point of the Post Office authorities and to guarantee the safety of the public had not been considered between those gentlemen and himself. He was not aware that the London Electric Supply Corporation had ordered, obtained, and were laying down an experimental main insulated for the express purposes of meeting the conjoint objections of the safety of the public and the burying of the main in the earth. The parties, however, had expressed a wish to thresh out the question by experiments and see how it could be done. Both he and the representatives of the company had been perfectly ready to make any experiments to settle the matter. He had no doubt at all that a cable carrying a current from Deptford to London could be made which would not include the present disadvantages of the proposed main; and when that was obtained, it would banish the Post Office objections to the scheme of the Supply Corporation. He had, too, no doubt that a proper motor could be adapted to the alternating system. As to the term "potential competition," the witness said Dr. Johnson invented the word when going over a brewery once, when he said, "Here is a potentiality of wealth beyond the dreams of avarice." (Laughter.)

Mr. Russell Griffiths said this was all the evidence he proposed to offer on behalf of the City of London. He should have an opportunity later on of addressing Major Marindin.

Mr. Shiress Will, Q.C., then opened the case on behalf of the House-to-House Electric Light Company. This company is seeking for a licence and for a Provisional Order to light the districts of Chelsea and South Kensington. The learned counsel stated that the company was formed in January, 1888, and it had established a station at Lillie Bridge. The machinery was of the most complete character. Each set of plant was capable of supplying electricity for 4,000 incandescent lamps, and the completed station would contain 12 such sets. That would give a capacity of 48,000 incandescent lamps, representing about 100,000 lamps installed. The company was tied to no system, but they had begun with the high tension, alternating current converter system, which, he believed, was the best for the public and the companies. After expressing himself in favour of districting, Mr. Shiress Will proceeded to speak of the relative merits of the different systems which had been submitted to the inspector.

It was stated, in reply to Major **Marindin**, that the application for a licence and a Provisional Order was opposed by several local electric light companies.

Mr. Robert Hammond, director of the House-to-House Lighting Company, and also of the Brighton and Hove and Eastbourne Companies, said the House-to-House Company had a capital of £350,000, of which £41,000 had been subscribed. The station at Lillie Bridge was capable of taking in much greater machinery than it had at present, and there would be no difficulty in raising the capital necessary. He was distinctly in favour of districting. His company was not bound to any one system of supply, and could adopt any improvements which might be made. He thought that a standard price should be fixed, based on the dividend—a dividend of 10 per cent. being fixed as the *masimum*, any increase of dividend to go in reduction of price. He considered that the high tension system with alternative current and transformers was the best, and one which could be speedily applied and extended.

In reply to Mr. **Moulton**, Q.C., the witness said his company was content with the district allotted to them; but they were ready to take up an extension of their district on the failure of any of the companies to which the other part of the district had been allotted by the local authorities.

In reply to Mr. **Wallace** (for the Kensington Electric Company), the witness said that the company proposed to charge for the light on a sliding scale. The company bound itself to no one system of electricity, but the system which it worked with was the high tension, with alternating currents and converters, and he insisted that the manner in which this was carried out was economical and efficient. He declared that the systems of the other companies were not economical. He examined in detail the several systems adopted by the several companies, the cost of installation, and the particulars of laying mains and cables. He contrasted these costs with the estimated cost of the laying the plant of the House-to-House Company's system, which, he declared, would be vastly cheaper. This system was at work at Eastbourne and Brighton, in one case by overhead wires and in the other by underground. Within a month of the order being obtained the company could supply the light; for while the other companies would only go where there was a great demand this company, owing to the cheapness of its mains, would go anywhere. The local authority had given its sanction to this system, which was actually at work.

The engineer of the company, Mr. W. Lowrie, having been called and examined,

Prof. **Forbes** was re-called, and said he had seen the station of the House-to-House Company at Lillie Bridge. From a general view of the condition of Kensington he had come to the conclusion that the alternating current system would be the best with which the district could be lighted.

The inquiry was then adjourned.

On the resumption of the inquiry before Major **Marindin**, on Thursday morning, at the Westminster Town Hall,

Professor **Crookes**, F.R.S., was first called on behalf of the Notting Hill Electric Lighting Company. He said he was the chairman of the company. The company has made arrangements for raising the preliminary capital, but had not at present made any effort to get money from the public. The nominal capital of the company was £100,000, and the undertaking might be considered to be a private one, promoted by a number of wealthy individuals resident in the neighbourhood, who were quite willing to find all the necessary funds without going to the public. Some of those who had provided the means were among the largest owners of property in the neighbourhood. The directors were prepared to subscribe sufficient capital to start the works, and to carry out the directions of the Provisional Order if it was granted. There had been considerable negotiations during the past three years with the Vestry of St. Mary Abbotts, Kensington, and searching investigations had been made in order that satisfaction should be given to the vestry as to the capabilites of the company.

In reply to Major **Marindin**, Mr. Wallace stated that there was no opposition to the Notting Hill Company. They did not object to an arrangement giving the vestry power to approve of other companies lighting the district, provided the Notting Hill Company did not perform the work satisfactorily. He thought, however, that it should operate in such a way that the Notting Hill Company could be heard in opposition to such a change. All they said was, that as long as they were doing their work properly, they did not want anybody to come into their district, but in the event of an objection being lodged that they were not doing their work properly, the Board of Trade should hold a proper inquiry.

The witness, continuing, said the directors had subscribed for 15 shares each, so as to provide the necessary funds to pay the preliminary expenses.

Mr. **Wallace** then opened the case on behalf of the Kensington and Knightsbridge Company, which, he said, had been in existence for about three years. The company included, for the purposes of the provisional order, the Kensington Court Electric Lighting Company, and the two were asking for the same order. There were two stations in the proposed area of the company, which, although it appeared a large one on the map, was really only one mile square. Mr. Crompton had given great attention to the development of the electric light in the district, and the supply was of an excellent character. There was a slight difference between the course the Kensington Company advocated and the policy advocated by the promoters of the other schemes. The principles proposed by the promoters of the various undertakings might be divided into three parts. There were those people who desired to have concurrent powers over the same area; there were those who believed in "districting;" and there were those who urged that the promoters of the company should be resident, and the capital of the undertakings should be raised, as far as possible, within the district, and that the stations should be situated close to the area of supply. This last was the policy which the Kensington company advocated. With regard to the question of concurrent powers, he thought it right to mention that in the Kensington district there were streets very similar to the streets that had been spoken of by the local authorities of the Strand and other districts. In the High Street, Kensington, especially, they had a very narrow thoroughfare, in which the traffic was congested to a very great extent, and there was the same mass of mains under the street as was to be found in the Strand. His company had especially considered, and had more experience than any other company in London on, the subject of breaking up of streets and main-laying under streets, and unless a scheme for making a subway for the purposes of all the competing companies in the same district could be arranged, great difficulties would arise. Considering the congested state of the thoroughfares, this company very much objected to any other company coming into Kensington.

Major **Marindin** asked what company was expected to come there.

Mr. **Wallace** said the Metropolitan Electric Light Supply Company proposed to come to Kensington. He certainly believed that "districting" was the best plan. If a competing company came to Kensington the streets they would all make for would be those in which the traffic was now most congested, because where there were more shops more light would be required. He considered that the High Street, Kensington, and the Brompton Road would be the very places that competing companies would most like to serve, and those thoroughfares would be a general battleground. In conclusion Mr. Wallace said that the capital of the company had been subscribed on the understanding that the Provisional Order would be granted. His company was the pioneer in respect of carrying out electric lighting under the system which had been described, and he pressed that it would be very unfair if they were interfered with.

Mr. R. **Erskine**, the secretary of the company, was called, and bore out the statements of Mr. Wallace.

Mr. **Wallace** then opened the case of the Westminster Electric Light Supply Company, and said that as that undertaking proposed to work on precisely the same system as the Kensington and Knightsbridge Company, he did not propose to prolong the enquiry by any further remarks.

After a brief discussion as to the future procedure of the enquiry, the Court adjourned.

The adjourned enquiry was resumed at Westminster Town Hall on Wednesday, April 24th, before Major **Marindin**.

Examined by Mr. Wallace, Mr. J. Brown Martin said he was a director of the Westminster Electric Supply Company. The nominal capital of the company was £100,000, which had been subscribed for the purpose of purchasing sites and putting up plant adjoining Victoria Mansions, Westminster. A great many gentlemen who had subecribed to the company were large owners of property in Westminster; he himself owned a large amount of property. They had secured three sites, and had been negotiating for two more; two of these sites were river sites. They had entered into contracts with Messrs. Crompton and Messrs. Latimer Clark, Muirhead and Company, for the erection of plant; the parish of St. George's, Hanover Square, to be lighted by Messrs. Latimer Clark, Muirhead and Company, and the parishes of St. Margaret's and St. John to be lighted by Messrs. Crompton. The property at Victoria Mansions had been purchased, and the boilers, dynamos, and other portions of the machinery were ready for delivery. He expected the plant would be erected within a month or six weeks.

In reply to Mr. Pember: They had about twenty shareholders, and he himself was the principal shareholder, holding some £50,000 worth of shares. All contracts were within £8,000.

Mr. Latimer Clark, examined by Mr. Wallace, said he was at the head of the firm of Messrs. Latimer Clark, Muirhead and Company. He had had considerable experience in manufacturing electric appliances, and in the laying of underground mains for telegraphic purposes. His company had erected the St. James's central station, which was now working satisfactorily. They had a contract for the supply of plant for the lighting of St. George's, Hanover Square. In answer as to how long it would take to supply a plant of 40,000 lights, the witness said it would take from six to seven months to complete, including the laying of the mains.

Mr. Killingworth Hedges, an electrician, was examined, and said he was anxious on behalf of clients to get the electric light in the parish of St. Margaret's. There was a great demand for it, and he thought that all lights provided would be at once taken up.

Mr. Muirhead, representing the St. James's Electric Lighting Company, said he objected to the London Electric Company and the Metropolitan Company being granted provisional orders on the following grounds: The St. James's and Pall Mall Electric Light Company was incorporated at the beginning of March last year, and was started in the St. James's district. The reason for commencing was that there was great dissatisfaction in some parts of St. James's at the unsatisfactory lighting by the Grosvenor Gallery Company, and it was at the request of a great number of people in the district that a company should be formed which could devote its attention to the requirements of the parish. The area in the parish may be divided into two areas—one south of Piccadilly, which contains all the clubs and a great many public buildings which require lighting; the area lying to the north of Piccadilly is a poorer district, which is inhabited by small working people, and this district would require motive power. So when the St. James's Company designed their system of supply they resolved to establish two stations, one in the south and the one in the north. In the southern portion the stations should be specially adapted for lighting purposes. In order that the northern station should be of use in a general system, it was designed that when the current was turned off in the northern portion of the parish it should be utilised in the southern portion to assist at the time of maximum supply. Soon after the incorporation of the company a licence was applied for, and after prolonged negotiations this licence was granted by the Board of Trade in December last. He might say that the St. James's Company did not intend to go beyond the boundary of the parish, but merely desired to meet the requirements of the parish. Having that object in view, they accepted all the amendments proposed by the vestry. The capital of the company was fixed at £100,000, but of course they had powers of increasing this. At the time the company was issued to the public, a prospectus was sent out setting forth the objects of the company, and while the subscription list was open, the Grosvenor Gallery, to protect their own interest, doubtless, and to prevent the successful floating of the St. James's Company, issued a map covered with red patches, to show that the ground was practically occupied. This, however, did not affect the floating of the company. £28,000 was subscribed in the first instance, and the number of shareholders on the list was about 60. The company then purchased a site in Mason's Yard, the cost being £9,500; they then spent in the construction of the building £8,500, and entered into a contract for the supply of machinery for 10,000 lights at a cost of £18,500. This contract was divided into two sections, the first section for 5,500 for £11,000, the second section making up the lights to 10,000, £7,500. The first portion of the contract is now practically completed, and the company is about to lay down the first section of the mains. The system adopted by the company was the low tension system. The system of distribution is known as the three-wire system, and the company propose to establish a network of mains through every street in the southern part of the district. There would be a main running down St. James's Street, along Pall Mall, up Regent Street, and along Piccadilly, and this main would be connected by means of feeders at the station. He did not think it would be necessary to call any scientific witnesses with regard to the system of distribution and machinery, as the system was very well known, and beyond minor matters of regulation, he did not think it possessed any novelty.

Mr. Eustace Balfour, examined by Mr. Muirhead, said he was the Chairman of the Board of Directors of the St. James's Company, having been connected with it since its formation. He was an architect by profession, and possessed a general knowledge of machinery. Had paid personal attention to the erection of the machinery at Mason's Yard. The central station was to be in Mason's Yard, the company having acquired the freehold of the premises. They had commenced operations, and were giving very great satisfaction. It was proposed to establish another station in the northern area, and to connect the system with the southern, so that in the event of a total breakdown of the machinery in the southern station, the northern would be able to produce a current. The current they proposed to supply would be capable of supplying storage batteries and motors. Eventually the company would use the storage batteries as well as the other system. The boilers had been specially constructed, and had given every satisfaction. They did not anticipate any complaints on account of nuisances. They had had one complaint when they first started, but it was of little importance and soon remedied.

By Mr. Pember, the witness said the system was a direct system without batteries, but they intended to use them. He was an enemy of competition in the sense that he thought that every company started under favourable auspices ought to have a chance in its own district.

Mr. Hemmerde, examined by Mr. Muirhead, was a director of the St. James's Company, but had confined his attention more to the financial part of the business than to the electric. The paid-up capital of the St. James's Company was £28,000. A deposit of £2,000 had been made to the Board of Trade, and he understood this would be released as the works proceeded. Should the works be successful, a large amount of capital would be secured.

The objections of the various vestries were then gone into.

Mr. Stokes, who represented the Rotherhithe Vestry, said the Vestry did not object to the principle of the Bill, but to certain clauses; they only required a protection order particularly as to overhead wires.

Mr. Legge, surveyor to the Vestry of Rotherhithe, in examination, considered the clauses enabling a company to alter the position of any pipes or wires in any street belonging to other companies was harmful and likely to lead to disputes, besides probably causing stoppage in the drains.

The objections of the Paddington Vestry, represented by Mr. Nash, were taken. The objections were that each of the companies which applied for Provisional Orders practically proposed to restrict its operation to private individuals, and not to undertake the public lighting of the streets, with this essential difference, that whereas the Metropolitan Company proposed to take the whole of the parish, the Storage Company wished only to take a small part, the richest portion of the parish. There was no very great demand for electricity in Paddington, and therefore that would seem to be a strong reason why no powers should be given to companies simply to enable them to experiment at the expense of the inhabitants. A further objection to the Storage Company was that the proposed capital for this particular undertaking, £60,000, that £30,000 to be allocated to the Paddington area was to be subscribed by individual shareholders of the company. That seemed to be very objectionable. In fact, it would be better, having regard to the public convenience, that these powers should be granted not to the applying companies, but to the authority in the district, which could more cheaply and more effectually, and generally in a better manner, administer to the wants of the neighbourhood in every respect. In conclusion, he said he had no doubt the vestry would be prepared to undertake the lighting of the district.

Mr. Dethridge, Vestry Clerk for the Paddington Vestry, in examination, said the vestry was anxious to obtain Provisional Orders for lighting, and the matter had been under consideration for several months. The services of two experts had been retained, and a very favourable report had been the outcome.

Prof. Forbes then gave evidence as to the feasibility of the plan of the vestry having Provisional Orders.

Mr. H. L. Cripps, on behalf of the Strand District Local Board, put forward the case of that body, who have consented to the application for one company for a Provisional Order, subject to certain conditions.

(To be continued.)

Lecture on Electromotors at Heriot-Watt College.—At the fortnightly meeting of this society, held in the college, March 15th, Mr. Alfred Hay read a paper entitled "Electromotors." For the benefit of the members not specially engaged in the electrical line, he first gave a sketch of the properties of magnets and electric currents, showing their relation to one another very clearly by a number of experiments. He then proceeded to deal with electro-magnetism, and Faraday's discovery of electro-magnetic induction, which forms the principle of the construction of electromotors. Having discussed the preliminary points necessary to the understanding of the subject, he next gave a short sketch of the history of electromotors, and described some of their early forms. The apparatus for the various experiments was lent by Principal Ogilvie, one of the honorary presidents of the society.

NOTES.

Electric Lighting in Spain.—A project is on foot for introducing the electric light into Irun. Power is to be obtained from La Cascade waterfall in the neighbourhood. Negotiations are also on foot for establishing an electric light installation in the town of Orihuela.

Electric Light in Algeria.—There has been lately established at Milianah a central station in which are employed two dynamos of the Manchester type, driven by a Meunier turbine. The total output is 210 ampères. The installation is erected in a mill outside the town, and the main cable is 1,600 feet in length; the distributing mains are spread over a distance of about three miles. At present there are used for public lighting 40 glow lamps of 20 C.P., 25 of 50 C.P., and several lamps of 200, 300, and 500 C.P. All the Municipal buildings are also electrically lighted. The installation was carried out by M. Feray, of Essonnes, and cost £2,200.

The Electric Light in Paris.—A commencement has just been made with the laying of underground mains for electrically lighting the large Boulevards of Paris. An offer has been received by the Municipality from the "Société Anonyme d'Eclairage Electrique du Secteur de la Place Clichy" to light up the front of St. Lazaire railway station by means of four powerful arc lamps. This proposal is now under consideration.

The Electric Light in Amiens.—A central station is being erected in this town, and subscribers have already been received for 4,000 to 5,000 lights. Among the buildings to be lighted is the Cathedral.

Increased Use of the Electric Light at Buckingham Palace.—According to *Truth*, the electric light has been very considerably extended in Buckingham Palace of late, and the entrance hall, the marble hall, the grand staircase, the ball room, the picture gallery, the promenade gallery, the dining room, the blue drawing room, and the saloon (famous for the three superb crystal chandeliers which it contains), are all now lighted by it.

Electric Light at Redruth.—On Saturday night an unusual illumination of a part of Clinton Road, Redruth, was observed, caused by the electric light which was casting forth its beams from the front room on the ground floor of and from the fan light of the entrance to Helford Villa, the residence of Mr. R. H. Michell. This gentleman has supplied his house with the necessary fittings for the purpose, and stores the electricity in accumulators by utilising the power of the engine which he has on his premises while performing other work in the daytime.

Norwich Town Council and the Electric Light.—At a meeting of the council, Mr. Hackblock moved "That the council endorse the application of Messrs. Laurence, Paris and Scott, Limited, to the Board of Trade, for a Provisional Order, similar to that adopted by the Ipswich Town Council, and that if the order is obtained, this council will further, in any way that is lawful, the carrying out of electric lighting in this city."

Fishing by the Electric Light.—There is fresh astonishment at hand for those dwelling in the deep between the Isle of Man and Anglesey, in the shape of a four days' dredging expedition in the Liverpool Salvage Association's steamer *Hyæna*. It is organised by the Liverpool Marine Biology Committee, and the successful experiment of last year is to be repeated—that of lighting up the bottom of the sea by electricity. The electric light is to be let down in townets. Crustacea and other creatures of the deep will come to it—this has been proved already—as moths to a candle flame and salmon to a torch light.

The Electric Light in Ambulance.—The French military authorities are preparing for a series of experiments with electric lamps specially designed for ambulance work. Men of the service are to lie down on the field, crawl under bushes, and into ditches. It will be the duty of the others to discover, with the aid of their lanterns and lighting apparatus, these pretended wounded. Electricity has never been applied to a more merciful undertaking.—*Newcastle Daily Chronicle.*

Bournemouth Improvement Commissioners and the Electric Light.—A recommendation of the Roads Committee that permission should be granted to the Anglo-American Brush Electric Light Corporation to erect 10 iron standards in Exeter Lane gave rise to considerable discussion, several members being of opinion that it was undesirable to take any step which would be likely to encourage the placing of further wires overhead. An amendment to strike the clause out of the report, and a further amendment to refer the matter back to the committee for further consideration, were defeated by six votes to five, and the recommendation of the committee was ultimately agreed to.

The Telephone in France.—The number of subscribers to the French General Telephone Company increased last year by 1,016. The advance is most noticeable in Paris, where the addition amounts to 846. In the French provinces there has been less progress made, and in two instances, viz., Calais and Oran, there has been a decrease. The following table gives the numbers of subscribers to the system on 31st December, 1887 and 31st December, 1888 :—

	1887.	1888.	Difference.
Paris ...	5,274	6,120	846 *
Algiers	89	94	5 *
Bordeaux	404	440	36 *
Calais	86	67	19 †
Havre	235	275	40 *
Lyons...	731	755	24 *
Marseilles	400	449	49 *
Nantes	106	114	8 *
Oran ...	38	36	2 †
Rouen	119	146	27 *
St. Etienne	108	110	2 *
Total	7,590	8,606	1,037 *

* Increase. † Decrease.

Personal.—The lamp works at Chelmsford being closed, Mr. Swinburne has entered into partnership with the Earl Russell and Mr. H. S. Holt, and Messrs. Swinburne & Co. have secured temporary works at Teddington. Mr. Swinburne's address for consultation is 49, Queen's Road, Wimbledon.

The Telegraph Manufacturing Company, Limited.—The directors of this company beg to inform their friends and customers that Mr. J. Slater Lewis has resigned his position as Managing Director of the company, and has no longer any connection with, or interest in, it. All letters should be addressed to the Telegraph Manufacturing Company, Limited, Britannia Telegraph Works, Helsby, Cheshire. On Mr. Slater Lewis's behalf we alluded to the step he had taken in our last issue.

Interesting Experiments.—M. de Fonvielle has made very curious electrical experiments at the summit of the Eiffel Tower. Some, it is considered, will lead to important considerations of a scientific character, which will be continued; others are of a more practical character. The atmosphere round the tower at this elevation is free from all influence of the soil, as would be the case at the top of a mountain, and the air is in an extraordinary active state of electricity. The tower will, it is said, be the most perfect conductor of electricity during a storm, and all within it will be in a state of entire immunity against all danger from lightning. The pretty idea has been suggested of having a carillon of bells at the top, which will play every two hours.

The Callender Waterproofing Company.—The American correspondent of the *Manchester Courier* telegraphed last week from New York as follows:—Sensational stories were started in New York that all was not right in the failure of the Callender Waterproofing Company, of Newark, New Jersey, and New York, which collapsed ten days ago with large liabilities. There is said to be a discrepancy of $300,000 or $400,000 in its finances that cannot be accounted for to the satisfaction of some of the stockholders. The company is an English concern that came over here in 1883 to make insulated cables, with a capital of $800,000. Mr. Henry W. Callender, of London, was made president, and his brother George the secretary. It is said that bonds to the amount of $400,000 were issued and sold in England recently, bringing $250,000, and in September last $300,000 were raised by mortgage on the Newark property of Mr. William J. Davis, of Newark. One of the stockholders said that when the company came to Newark about five years ago it located on the property owned by him. He allowed the company to occupy about three acres of land, and took some stock and mortgage. The company erected a brick building one storey high, about 200 feet long, and several smaller buildings were put up afterwards. Valuable machinery was imported from England, and when the company failed the factory and contents were valued at from $100,000 to $200,000. Most of this valuation was made on the machinery and patent rights controlled by the company. In business circles the failure of the company was attributed to the lack of the demand for insulated wires and cables. Dissatisfied stockholders attribute the failure to the bad management of the finances by the Callender family. Much of the trouble is said to have been due to the suit of Sir B. Cunard against his cousin, Mr. Charles E. Francklyn. The latter invested $300,000 in the Callender Company's stocks, and when Sir B. Cunard called Mr. Francklyn to account for his financial dealings, this stock formed part of the disputed property. It was through Mr. Francklyn that Messrs. Callender were induced to locate in this country. He knew them in England, and told them what a beautiful field America was for enterprises. Mr. W. J. Davis, who was for a time counsel for the company, said he believed there was shortage, but as soon as Mr. William Callender could be communicated with everything would be satisfactorily explained. It is rumoured that President Callender is now in London, but his family declare he is still in America.

Waterproof Electric Motors.—Some time ago a statement made by Mr. Frank J. Sprague that it was possible to have electric motors washed after use, met with a considerable amount of ridicule. According to experiments recently made at the factory of the Thomson-Houston Electric Company at Lynn, Mr. Sprague's assertion is proved beyond a doubt. One of the company's ordinary motors was fitted with a newly designed armature, and while running with a difference of potential of 500 volts at the brushes was doused with pails of water. The motor ran as quietly as under ordinary circumstances and passed through this severe ordeal without the least harm. This is due to the fact that the armature was so wound as to give the greatest possible amount of insulation between points of great difference of potential and to other special features of construction. The success has been so complete that it has been proposed to make this experiment a standard exhibit and test at the Thomson-Houston factory.

Good News! — Electric Lighting in the Inner Temple.—The elaborate preparations commenced some time since for the purpose of illuminating the chambers and offices in the Inner Temple generally with the electric light, have now been definitely abandoned, and the extensive excavations, &c., made in the Inner Temple Gardens, for the reception of the plant and machinery necessary for the purpose, are now being filled in, and the gardens will shortly resume their usual appearance.

Discussion as to the Merits of the Sprague System.—During a recent discussion in an American city as to the adoption of an electric system, it was decided to send a telegram to the mayors of towns and cities where the Sprague system was being used. The result was a unanimous reply in favour of the system.

Great Increase in the Use of Telegraphy and Telephony.—The remarkable manner in which telegraphy and telephony has progressed in 1888 is shown by the following figures. The number of telegraph offices throughout the world has increased in 1888 by over 7,200; the 10,000th office, according to *Kuhlow's Gazette*, was opened in Germany during last year. Telephones have also undergone a similarly great extension. At present there are 750 exchanges in America, with 200,000 subscribers. In Germany there are 174 exchanges and 32,920 subscribers.

Glasgow Philosophical Society.—At the last meeting of the Glasgow Philosophical Society Mr. Bottomley explained the methods followed in measuring the electric resistance of glass plates, and exhibited specimens of glass which had been experimented upon in connection with the making of a large electric machine for Sir Archibald Campbell, M.P. He also exhibited curves showing how the resistance was calculated. Mr. Bottomley also showed two Leyden jars which had been broken by an intense charge of static electricity, and pointed out the curious properties of the fracture.

How the Cable was Repaired at Tangier.—A very odd story is that told by the Tangier correspondent of the *Times* as to the recent visit of our fleet to the Moroccan seaport. Two years ago, he tells us, Sir William Kirby Green, the British representative at Tangier, laid a cable from Gibraltar to Tangier in opposition to the native population, the Moorish Government, and his own colleagues. The Sultan was so hostile to this act that he offered to pay a large sum of money for its removal, and his subjects cut the wire on the beach. As the wire that the natives were allowed to cut was a bogus duplicate, no interruption took place in the secretly, and, perhaps, illegally, established cable communication between Europe and Africa. The other day the cable needed repairs. The Sultan would not permit these repairs to be executed until the European Powers agreed. The European Powers would not agree, and the result was that in order to keep up the advantages gained by the surreptitious laying of a cable no fewer than five of our ironclads were despatched to Tangier, and under the shelter of their guns the cable was repaired.

The Symington Memorial.—A movement has been initiated with a view of providing a suitable memorial to Willam Symington for having produced the first practical steamer. It was in 1788 that William Symington, under the patronage of Mr. Patrick Miller, of Dalswinton (a wealthy Edinburgh banker, and an experimenter in naval architecture), applied the new steam engine which he had patented in 1785 to a pleasure boat belonging to Mr. Miller, and on October 13th, 1788, performed the first successful experiment in steam navigation. Seeing that both Fulton and Bell were undoubtedly indebted to Symington's *Charlotte Dundas* for some of their ideas and as monuments have been raised to the honour of both of them, surely something should be done to commemorate the name of William Symington, who was reduced to a state of poverty by his experiments, and who now lies in the churchyard of St. Botolphs, Aldgate, without even a simple stone to mark the spot.

The Phonograph in Belgium.—The committee of the higher courses of instruction for ladies having asked M. Bède, the well-known Belgian engineer and Communal Councillor, to give an account of the Edison phonograph, he accordingly delivered a lecture on that subject at the Palais des Académies, Brussels, last week.

Engines and Boilers for the Paris Exhibition.—Messrs. Davey, Paxman & Co., of Colchester, whose engines and boilers have acquired a world-wide reputation, especially after the splendid results obtained at the Fisheries, Health, Inventions, and Colonial Exhibitions in London, and afterwards at the competitive trials of the Royal Agricultural Society of England at Newcastle, 1887, and those held by the Society of Arts in London, 1888, are sending to the Paris Universal Exhibition a fine collection of steam motors, generators, and mining machinery. They are sending steam engines and boilers of about 1,500 total horse-power to the Exhibition, out of which about 300 H.P. is for supplying the motive power required in the British Section. This power will be given off by two engines, both of which are condensing, one of the coupled compound girder type and the other of the horizontal girder frame type. The remaining power, which will be used for driving electric lighting machinery, will consist of five engines, all of the compound receiver type, one 500 H.P. coupled compound girder engine, two of the well-known "Colchester" type, and two undertype compound engines with boilers combined. One small horizontal engine will be used for driving the mechanical stokers of the group of nine locomotive multitubular boilers which are supplying the necessary steam for the engines. In addition to the above-mentioned machinery, which will be at work during the whole time of the Exhibition, and thus directly contribute to the general success, they will also exhibit the patent Huntington quartz crushing mill, which is now causing such a revolution in the mining world, and also a Paxman and Allen's patent safety diamond washing machine, which is put down for and worked by the De Beers Consolidated Mines, Limited, of Kimberley, and of which a large number are working and giving great satisfaction in the diamond fields of the Old and New World.

Smart Reorganisation.—Recently the station of the Fostoria, O., Electric Light Company was destroyed by fire. While the ruins were still red hot the company telegraphed for new machines. An interruption of only five nights' duration was caused, though the works were completely destroyed. Since the fire the city council has made a new contract with the company for lighting the city for a term of five years, at $5,000 per annum, the light to burn all night.

Something Like a Draw.—A dispatch from Scranton, Pa., of March 21st, says: A week ago Charles Nier, of this city, ran a needle into his foot. Surgeons sought in vain for it. This afternoon Nier was taken to the plant of the Suburban Electric Railway and his foot held near one of the dynamos. In 15 minutes the needle was drawn out.

Telegraphic Communication between Glasgow, Gourock, and Greenock.—A change has been made in the transmission of telegrams between Glasgow, Gourock, and Greenock. Formerly, Glasgow messages had to be sent through the Greenock office. A direct wire has now been opened up between Glasgow and Gourock, which will be a great advantage to the residents in both places. With this change the direct wire from Greenock to Gourock has now been dispensed with, which will necessitate messages from Greenock to Gourock being sent through the Glasgow post office.

Paris Exhibition, 1889.—The British committee are desirous of drawing attention to the fact that all applications for Press passes to the Paris Exhibition should be made, not to the offices of the British section, but to the *Direction de la Presse Etrangère, Exposition Universelle, Champ de Mars, Paris*. The arrangements for all Press tickets are in the hands of the *Syndicat de la Presse*, who have at their disposal a certain number of admissions, a proportion of which are to be devoted to foreign newspapers.

Lecture on Electricity in Portrush.—A most interesting and instructive lecture on electricity was delivered by Mr. W. F. Hamilton, electrical engineer, Portrush, in the Town Hall, to a large and appreciative audience, on Friday evening last. The hall was brilliantly illuminated with a number of the Hamilton patent incandescent lamps. The lecture throughout was of an entirely practical nature, the details of electric lighting being fully dealt with, more particularly with regard to the lighting of Portrush, the cost of doing so, excluding fittings inside the houses, Mr. Hamilton stated, would be about £1,500, and that for economy and efficiency the light would compare most favourably with gas.

The Smith Electric Conduit System.—The Smith conduit, an American invention, is an hermetically sealed tube or box which is laid midway between the rails of any car-track. It contains the insulated electric conductor on its inside bottom surface, and its upper or exposed surface is covered with a series of non-magnetisable metallic plates, each about 4 feet in length, which are screwed down on to strips or sheets of insulating material, and each insulated from its neighbour, so that the surface of the conduit becomes a strip of metal, broken up into sections of not more than 4 feet each, from which the car, in passing along over its surface, may take off and use a current of electricity, provided they are, for the time being, directly connected with the source of supply at the bottom of the conduit. This connection is made in the following manner: At distances of 1 or 2 feet apart, movable connecting pieces are attached to the electric conductor, and rest thereon by gravity until such time as they are attracted from above. The car is provided with a row of magnets on its under surface, which pass along close to the metallic top of the conduit, and, in passing, attract by magnetic influence the connecting pieces before referred to, each of which is provided at one end with a small soft-iron armature. As these "connectors" each rise up in their turn through small holes in the top board of the conduit, on touching the lower part of the surface plate, they form a direct electric connection between the cable and such top plates as the car and its magnets cover; so that such parts of the top plates, and only such parts, are always in electrical connection, and form the medium from which the car in its passage is supplied with its current and power for its electromotor. We believe that something of this kind was suggested a year or more ago in this country. Perhaps some of our readers may be acquainted with the actual facts of the case.

Electric Tramway Cars in Liverpool—The Health Committee have recommended that the Corporation consent to the Liverpool Tramways Company moving tramway cars by means of electrical power on the lines of the Walton route, from the Old Haymarket to the city boundary, on certain conditions.

Society of Arts.—On Wednesday, May 1st, at 8 p.m., a paper on "Secondary batteries," by William Henry Preece, F.R.S., will be read.

An Interesting Compilation.—Mr. Fred H. Whipple, Detroit, Mich., whose works have often been noticed in the REVIEW, will issue in June a complete directory of the electrical fraternity, including every person in every branch of the trade, and proposes to supplement this monthly, until the next annual number, with commercial reports embracing the doings of the electrical world up to date. These reports will be in the nature of confidential bulletins on the progress of the business world, confined entirely to matters electric, and will be sent only to annual subscribers. We would gladly welcome such a volume in this country, but the electrical fraternity is at present, we fear, too limited in numbers to make such a venture successful.

Is Electric Locomotion a Failure?—The failure of the Elieson Company to effect a sale of its patent rights and general plant is not altogether surprising, but we expected that much more interest would have been taken in the attempt. Certainly the auctioneers were not to blame, for no expense had been spared to make the matter known far and wide, therefore it is difficult to understand the extreme apathy with which the project was met. We have heard expressions of opinion in various quarters that article 10 of the conditions of sale in the illustrated catalogue produced a bad impression. It apparently led intending buyers to believe that after purchasing the patent rights they might find that they had not complete possession of them. It is possible, however, that some personal motive might have been the *raison d'être* of the objectionable clause, but with this we have no concern. It is evident, however, that there are facts connected with the fall of the Elieson Company which should be disclosed, for very large sums have been spent in a short period of time, and it is only right that the shareholders, at least, should know exactly what has led to this disastrous termination. We must not lose sight of the fact that the Stratford Manor Park line was to have been wholly worked by electric locomotives, and we may well ask why the old engines were not put in thorough repair and new ones built, so as to carry out the original idea, for there was certainly money enough, and to spare, for the purpose. Did the directors ever anticipate success, and if so, what were their plans? If only for the cause of electric locomotion generally, we hope that a statement may be forthcoming to show that it was not the cost of running which brought about the downfall of this once promising company.

Aluminium in Austria.—The Austrian Länderbank and the Allgemeinen Elektricitäts Gesellschaft have purchased a patent for the electrical production of aluminium. The process is to be carried on in the Alpine district, and water power will be used to drive the machinery.

Electricity in Mines.—The Belgian Government has lately appointed a commission to enquire into the employment of electricity in mines, and as to its safety. Among the questions to be considered is the use of portable electric lamps.

The Paris Exhibition.—The tramway between the Quai d'Orsay and the Champs de Mars is to serve for the exhibition of various mechanical systems of traction. Among these electric motors will find a place.

Obituary.—On Friday evening, at the age of 74, Dr. Warren De La Rue died after a short illness. He was born in the island of Guernsey in 1815 and educated in Paris. Besides distinguishing himself in the application of photography to the recording of celestial phenomena, he fitted up in 1874 a private physical laboratory, and carried on a series of researches on the electrical discharge. The results of the researches have been from time to time communicated to the Royal Society and the Academie des Sciences, Paris. "The phenomena of the electric discharge" was also made the subject of a most interesting lecture at the Royal Institution in 1881. For a number of years he was president and member of various scientific societies and institutions, and several foreign orders have been conferred upon him.

The Preservation of Telegraph Poles.—Telegraph poles are preserved in Norway by making an auger hole about 2 feet from the ground, in which 4 oz. or 5 oz. of sulphate of copper in coarse crystals are placed, and plugged in. The chemical is gradually absorbed by the wood, until its whole outer surface turns a greenish hue. The sulphate requires an occasional renewal, and is said to be a perfect preservative. This note has gone round the world, and will perhaps now turn up usefully before some who are about to put posts into ground. We do not know how the renewal is effected.—*Engineer*.

The Electric Light in the Russian Navy.—The Russian Minister of Marine has just arrived at a most important decision. All ships of war to be built in the future are to be lighted exclusively by electricity. The same illuminant is also to be installed as quickly as possible on board those vessels already constructed, so that, by January of next year, the whole of the Russian fleet will be lighted by the same means.

German Telegraphs and the State.—By virtue of a contract of sale the Vereinigte deutsche Telegraphen Gesellschaft transferred, as and from January 1st, to the German Empire its Emden cables touching Lowestoft and Valentia. In consequence, this company ceased to exist on the 17th inst.

The Northfleet Electric Tramway.—The Series Electrical Traction Syndicate, Limited, have received from the Board of Trade a certificate that their electrical tramway at Northfleet has passed the Government inspection: and a license to use electricity as the motive power thereon for seven years has been granted. It was intended, therefore, that the line should in consequence be opened to the public immediately after the Easter holidays.

A Large Electric Power Plant.—The California Electric Light Company, of San Francisco, has erected at the Chollar Mine the largest electric-power plant in the world. It comprises six 120 horse-power Brush dynamos, each driven by a Pelton water-wheel with water under a head of 1,630 feet. The water is conveyed through two pipes of 8 inches and 10 inches in diameter respectively. The station is situated in the shaft of the mine, and the exhaust water is carried off by a tunnel to the Caron river. The current is led to the mill, where it drives six Brush motors of 125 horse-power each.

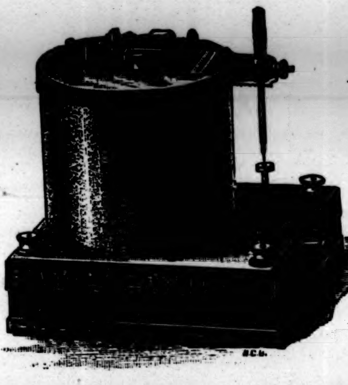
Devonshire Club to be Lighted by Electric Light.—The Devonshire Club is to be re-decorated throughout and fitted with the electric light. When this is done the committee believe that they will have in many respects a more attractive club house than is "the Reform."

An Electric Launch.—Mr. Bowen's electric launch, *Ray Mead*, was launched on Thursday, and passed through Boulter's on a trial trip on Saturday, which proved very successful. Electric Charging Station No. 1 is now stationed above Boulter's Weir. Is this one of Messrs. Immisch's ventures?

Paris Exhibition Lighting.—A preliminary trial of the electric light installation at the Paris Exhibition, of which a full and exhaustive account appeared in the ELECTRICAL REVIEW of March 29th, took place on the 17th instant. What made this trial possible was the activity displayed by the engineers of the Gramme Company, who are charged with the electrical portion, and by Mr. Bellars, representing Messrs. Davy, Paxmann & Co., who are in charge of the mechanical portion. The lustres, of which the lamps are disposed in series of three, were tried in succession. The first trial was the lighting of three lamps on each lustre; the second that of six lamps of two lustres and of three on two others; and lastly, the third on a complete lustre, six lamps on the following, and three on a third. These experiments were so successful that the anticipations of the promoter of the lighting were fully confirmed.

Novel Applications of Electricity.—Incandescent lighting in Chicago is being made as artistic as possible. In the Sherman House the small bulbs are surmounted by a large reflector which radiates the light. It is in the Grand Opera House that the most novel system is introduced. In front of the top of the proscenium arch a sort of ornamental sounding board is studded with incandescent lamps. These are thrown in circuit simultaneously, and light up the whole theatre.

Pyke and Barnett's Flame Spark Coil with Continuous Action Rapid Break.—Our readers will remember that some time ago we gave a short description of the above apparatus, and we now have great pleasure in illustrating the commercial model of the invention, at present made and stocked by Messrs. Woodhouse and Rawson. It will be seen from the woodcut that the design has been rendered more compact, and that the moving parts of the break (which is in the recessed centre of the coil) project above the top-board, for ready adjustment. The break is quite a new departure, and from its certainty of action forms, perhaps, the most valuable improvement in these coils. The principle of its action is as follows:—A hammer, mounted on a short thick spring, is very rapidly and vigorously vibrated by means of an electro-magnet included in a shunt circuit, and the main or coil contacts are so arranged that (one of them being mounted on a spring) on the recoil of the vibrating hammer it strikes against the movable main contact, and causes a slight and instant separation. The whole of the parts are arranged for ready and rapid adjustment, and the flat contacts are arranged on screws which are readily removable for replatinising. The arrangement of the dischargers is also very neat, and not so liable to damage as the old style. The size of the coil (No. 1) is 5 inches diameter by 4⅝ inches high. Other sizes of this convenient high tension current generator will be shortly procurable.



Callender's Bitumen Telegraph and Waterproof Company, Limited.—The annual meeting of this company was held at its offices, 101, Leadenhall Street, on Wednesday, April 17th, at 12 o'clock, Sir Geo. R. Prescott, Bart., Chairman of the Board of Directors, presiding. A most satisfactory report of the year's working was presented, showing a very large increase of business during 1888, and a dividend on the ordinary shares declared, a substantial sum being carried forward to the reserve fund. Sir Geo. R. Prescott and Mr. Henry Drake were re-elected directors, and the proceedings, which were unanimous throughout, terminated with a cordial vote of thanks to the directors and officers of the company.

NEW COMPANIES REGISTERED.

Patentees Company, Limited.—Capital £25,000, in £1 shares. Objects: To construct, manage, and control public works of all kinds, including electric light, telephonic, and telegraphic. Signatories (with 1 share each): J. Renwick, 58, Olinder Road, Stamford Hill; M. Sheerboome, 169, Grove Road, Bow; E. L. Manning, The Park, Nottingham; W. H. Booth, C.E., Castlemere, Rochdale; J. Walton, 85, Queen's Road, Finsbury Park; A. B. Haxell, Eskdale, Beckenham; F. W. Hartley, 1, King's Bench Walk. The signatories are to appoint the first directors. Qualification, 250 shares. The company in general meeting will determine remuneration. Registered office, Leadenhall Buildings, Leadenhall Street. Registered 18th inst. by Sydney Morse, 4, Fenchurch Avenue.

Brompton Electric Fittings Company, Limited.—Capital £2,000, in £1 shares. Objects: To supply public and private buildings with the electric light and the fittings for the same; also to manufacture electric bells, heating apparatus, and other articles, and to engage in artistic metal work of every description. Signatories (with 1 share each): Basil Gee, 146, Brompton Road, electrical engineer; N. J. Shield, 59, Bramber Road, S.W.; C. R. Heap, 7, Waldegrave Gardens, Strawberry Hill, electrical engineer; F. W. Medcalf, 106, Woodvale, Forest Hill; J. E. Edgecombe, C.E., Westgate-on-Sea; G. E. Hartmans, 28, Hartington Road, Ealing, electrical engineer; S. Jordan, 36, Gertrude Street, Fulham. Registered without articles of association on the 20th inst. by Deacon, Gibson, and Medcalf, 4, St. Mary Axe, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cadogan Electric Light Company, Limited.—At an extraordinary meeting of this company, held at the offices of the company, 91, Manor Street, Chelsea, on the 19th ult., resolutions were passed rescinding a resolution of the 1st September, 1887, authorising the issue of "B" shares, so far as the same provides that such shares shall be issued as fully paid up, and that they should be called "B" shares, and not receive dividend until 5 per cent. has been paid on the ordinary shares. The 3,000 shares of £5 each to be issued, are to be called preference shares instead of "B" shares, and will carry a cumulative preference dividend of 7 per cent. per annum on the amount paid up. The existing certificates of the "B" shares are to be called in and cancelled, and new ones issued in place thereof. At a meeting held at the same place on the 5th inst. such resolutions were confirmed, and were duly filed on the 18th inst.

Liverpool Electric Supply Company, Limited.—The annual return of this company, made up to the 9th inst., was filed on the 13th inst. The nominal capital is £200,000 in £5 shares. 20,000 shares are taken up, and upon 10,000 of these the full amount has been called and paid, and the remainder have been paid up to the extent of £1 per share.

Mudge Marchant Engine Company, Limited.—An agreement of the 10th inst. provides for the issue to the founders of the company of 2,560 ordinary shares of £50 each, fully paid up, in consideration of the assets brought into the company by the said founders, being estimated to be of the value of £128,000. Registered office, 5 & 6, Great Winchester Street.

Laing, Wharton and Down Construction Syndicate, Limited.—An agreement of 28th ult., filed on the 5th inst., provides for the purchase of the business of Laing, Wharton and Down for 100 fully paid up shares of £100 each, and in certain contingencies one-third of the shares (paid up) which may be issued, over 300 in number, until the full number of 400 shall have been issued.

Galloways', Limited (engineers and electricians).—An agreement of 11th inst. provides for the purchase of the business of Galloway and Sons, of the Knott Mill Ironworks, Manchester. The purchase consideration is as follows: £800 in cash, £12,159 13s. 7d. by the payment of the business debts of the vendor, and an allotment of 2,100 fully paid shares of £100 each, credited as fully paid.

Bath Electric Light Company, Limited.—The registered office of this company is situate at No. 2, Northumberland Buildings, Bath.

British Tanning Company, Limited.—The registered office is at 17, Basinghall Street, E.C.

CITY NOTES.

Great Northern Telegraph Company of Copenhagen.

According to the balance sheet the total receipts of the company during the year of 1888, including the balance brought forward from 1887, have amounted to £329,119 8 3

The expenses have been 64,440 2 10

which shows a net profit of £264,679 5 5

Payments already made :—

5 per cent. interest on debentures 1881 and 1883 issues £16,000 0 0

Amortization of 350 debentures 35,000 0 0

£51,000 0 0

And the board propose to distribute the balance as follows :—

Reserve and renewal fund ...		£55,555 11 1	
Pension fund of the staff ...		2,777 15 7	
Remuneration to the board of directors		1,500 0 0	
Interim dividends already paid ...	£75,000		
Final dividend proposed ...	37,500		
		112,500 0 0	
Making a total of 7½ pr. cent.			
Balance to be carried forward		41,345 18 9	
			213,679 5 5
			£264,679 5 5

The investments during last year on account of the reserve and renewal fund amounted to £37,218 3s. 10d.

The following resolutions are to be proposed for adoption at the general meeting:—"That the report and balance sheet be adopted, and that discharge be given to the board of directors." "That C. St. A. Bille, Esq., be re-elected as a member of the board of directors." "That A. Berner, Esq., and S. Bille, Esq., be re-elected as auditors of the company."

The Anglo-Portuguese Telephone Company, Limited.

In the report to be presented at the adjourned second ordinary general meeting of the company, to be held at the offices of the company, 53, New Broad Street, E.C., on Thursday, April 25th, 1889, at 3 o'clock p.m., the directors beg to submit to the shareholders their report and accounts of the company for the year ending December 31st, 1888.

After making all deductions the profit on the year's working amounts to £4,133 2s. 2d., making with the amount carried forward from last year the total amount of £5,827 19s. 7d., standing at the credit of profit and loss account. This amount it is proposed to carry forward to next year's account to be dealt with hereafter as the board may deem advisable.

The capital expenditure for the year amounted to £9,709 16s. 9d. The directors beg to state that it has been necessary to build a new exchange in Lisbon in consequence of the increased number of subscribers, and also to make extended switchroom accommodation in Oporto, to open up new and improved routes, as well as other works undertaken at the instance of the Government Fiscal. It is on this account that such a large outlay of capital has been incurred. The directors have every reason to believe that the result will in the early future repay the outlay.

The directors are pleased to report that the issue of £10,000 6 per cent. debentures made in May last was successful, all the bonds being at once subscribed for.

The number of paying subscribers at December 31st last, was :—

In Lisbon, 912, of a gross annual value of ...	£6,625
In Oporto, 721, " " "	£3,943
	£10,568

showing a total increase in subscribers of 210, and in value of £1,268 over the preceding year.

A new law having recently been enacted which the directors consider to be at variance with the terms of the concession granted to the company, and which may possibly become somewhat harsh and vexatious in its application, the directors are taking such steps in Portugal as they consider necessary to protect the company's interest.

Dr. Frederic Clift, having ceased to be a member of the board, and an application on behalf of the debenture holders having been made that they should be represented, Mr. C. L. W. FitzGerald, as representing that interest, has been elected to fill the vacancy.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., being eligible, offer themselves for re-election.

The meeting of the above company took place on Thursday, but as reporters were not admitted we are unable to give a report.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 12th, 1889, were £1,220; and for the week ending April 19th, 1889, were £1,057, both after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th April are £3,732, as compared with £3,012 in the corresponding period of 1888.

AMERICAN NOTES.

By DAS TELEPHON.

The following statistics from the report of the American Bell Telephone Company may be of interest to telephone companies and users of that necessary but expensive instrument:—

	1884.	1885.	1886.	1887.	1888.	1889.	Increase over 1888.
Exchanges	906	772	747	736	739	742	3
Branch offices..............	419	481	428	446	452	452	.
Miles of wire on poles......	..	88,481	100,332	111,349	127,839	142,631	14,792
Miles of wire on buildings..	..	11,886	10,043	10,587	10,225	10,266	41
Miles of wire under ground	..	1,225	3,417	6,030	8,009	17,068	9,029
Miles of wire submarine ..	..	..	254	265	365	536	171
Total miles of wire	85,896	101,592	114,046	123,231	146,438	170,471	24,033
Total circuits	97,422	107,440	112,067	121,280	132,004	143,687	11,683
Total employés	4,762	5,168	5,438	5,843	6,183	6,310	127
Total subscribers	123,625	134,847	137,750	147,068	158,712	171,454	12,742

Instruments in the hands of Licensees.

December 20th, 1884.	1885.	1886.	1887.	1888.
325,574	330,020	353,518	380,277	411,511

The mileage of wire is 243,764 as against 201,911 in 1887. Many of the local companies are replacing iron wire with copper for extra territorial work.

The statement of the treasurer shows that the gross earnings for the year were		$3,865,118 48
Expenses		1,450,913 26
Net earnings		$2,414,205 22
Miscellaneous credits...		22,258 34
Total		$2,436,463 56
Regular dividends paid	$1,192,152 00	
Extra dividends paid...	597,726 00	
Total dividends ...	$1,789,878 00	
Reserve for depreciation of instruments...	46,585 56	
Reserve for general depreciation ...	600,000 00	
		$2,436,463 56
The surplus account remains the same as it was last year		$2,028,035 92
Capital stock		9,962,100 00

Comparative statement of earnings and expenses :—

Earnings.

	1887.	1888.
Rental of telephones	$2,264,823 94	$2,453,279 34
Dividends	1,013,036 99	1,213,856 58
Extra-territorial and branch lines	80,443 67	78,711 18
Telegraph commission	19,962 31	21,164 92
Interest	70,235 68	90,466 65
Miscellaneous	4,525 11	7,639 81
	$3,453,027 70	$3,865,118 48

Expenses.

	1887.	1888.
Expenses of operation	$242,205 06	$274,442 00
Legal expenses	207,679 95	222,257 75
Interest and taxes	139,174 80	207,212 68
Commission	433,578 37	467,471 10
Royalty	11,000 00	10,000 00
Concessions	189,765 38	207,790 27
Miscellaneous	19,027 33	61,739 46
	$1,242,430 89	$1,450,913 26
Net earnings	$2,210,596 81	$2,414,205 22
Misc. items to surplus account ...	27,011 31	22,258 34
	$2,237,608 12	$2,436,463 56

On the first of this month the largest electric railway system in the world was put in operation in Topeka, a town in far-away Kansas.

The Thomson-Houston is the system employed in Topeka, and trials made every day this week indicate its complete success. Overhead wires are used. The cars are models of convenience and about the size of the ordinary cable car. Underneath the floor of each car are placed two 10-horse-power electric motors. From the roof of each car a trolley, with a strong spring on the end next the roof, and a grooved wheel on the other which is constantly pressed against the wire, conducts the current to the motors. On each platform is a "cut-off," with a lever not unlike a brake handle.

A speed of 15 miles an hour can easily be attained, but in Topeka the maximum rate allowed is 8 miles. The cars are lighted by electricity and are comparatively noiseless. They take curves with ease. Nine dynamos driven by two engines of 1,200 horse-power generate the electricity. The company will operate 43 cars.

Now that the telephone has become a necessity, the ever-growling public are crying out against the charges of the telephone exchanges, which are generally about $100 a year in large cities. The public cry out monopoly, monopoly, and refuse to follow that golden rule, "Do to others as you would be done by," and deny the right of the owner of property to set his price upon it.

The Legislatures of several of the States have passed laws fixing the annual rentals of telephones, and the latest attempt depriving the owner of his property is that introduced into the Legislature of Delaware a few days ago, to tax telephone companies $10,000 a year. The act provides that if the companies shall raise their rates on account of the tax imposed, they shall be fined a sum not exceeding $1,000. If the companies refuse to pay the tax, the sheriff of the county through which the line passes is to seize the wires and sell them to the highest bidder.

More rejoicing among the patent attornies is occasioned by the appointment of Mr. Robert J. Fisher to be Assistant Commissioner of Patents, who entered the Patent Office in 1875 as Assistant Examiner. Since that time he has passed through every grade of the service by regular promotion, including that of Examiner-in-Chief and member of the Board of Appeals, which position he now holds. His familiarity with the practice of the Patent Office, and the decisions he has given on the Board of Appeal gives assurance that so far as in him lies, the abuses which now exist in the Patent Office will be speedily remedied, and the ignorant examiners will be weeded out.

Charges are being prepared against Brown, the Examiner-in-Chief in the Electrical Department, setting forth his ignorance of electrical matters, and his overbearing conduct. There is no doubt he will be discharged. It seems he was the adviser of the late Commissioner, J. Benton Hall, whose decisions have given so much dissatisfaction.

Baltimore, *April 5th*, 1889.

ON THE DEATHS CAUSED BY LIGHTNING IN ENGLAND AND WALES FROM 1852 TO 1880, AS RECORDED IN THE RETURNS OF THE REGISTRAR-GENERAL.*

By ROBERT LAWSON, Inspector-General of Hospitals, LL.D., F.S.S., F.R.Met.Soc.

THE deaths from lightning during the 29 years, 1852–1880, amounted to 546; the number fluctuated considerably in different years; thus in 1863 there were three only, in 1864 six, and in 1869 seven, while in 1852 there were 45, and in 1872 46; the average during the period being 19. Numbers so limited do not afford a basis altogether satisfactory for generalisation, but by grouping them in periods of a series of years, their inequalities may be neutralised to a considerable extent, and some useful indications arrived at.

It appears that the deaths in the country generally in 1852–60 were 10·50 in ten millions living; these fell to 6·50 in 1861–70, and rose again in 1871–80 to 9·54, the mean for the whole period being 8·79.

In the counties of Essex, Suffolk and Norfolk, the rate in 1861–70 was about the same as that in the preceding period (1852–60), followed by a considerable fall in 1871–80, and in the counties of Leicester, Rutland, Lincoln, Nottingham, and Derby, the ratio in 1861–70 was considerably higher than in either the preceding or following period. It appears that the lowest ratio of deaths was in the metropolis, next to this comes the counties of Wilts, Dorset, Devon, Cornwall and Somerset (grouped together), with a ratio of 5·58, and then the Cheshire and Lancashire, with a ratio of 6·63. The highest ratios were 12·73 in the first-named counties, and 18·02 in the second.

In consequence of their greater exposure, the inhabitants of rural districts suffer more from lightning than those of towns, and the mortality from this in the different groups of counties will vary according to the relative proportions of the rural and urban populations in them. Besides this, however, the ratios indicate there are at least two other conditions which modify the results considerably, viz., vicinity to the west and south coasts, which reduces the chances of injury from lightning, and distance from the coast and highland, which seems to increase them. Thus the ratio of deaths from this cause is lowest in the metropolis, being only 1·30, then follows the south-western group with 5·58, next the north-western with 6·63, in which vicinity to the west coast and predominance of urban population concur to produce this result, then comes the south-eastern with 8·04; all these are under 8·79, the mean for England and Wales. The Welsh group, which embraces westerly exposure and much highland, has a ratio of 9·12. The ratio in the west-midland group at the top of the Bristol Channel is 10·67, while that in the south-midland, more in the centre of the country, is 12·28, and that of the north-midland, both inland and elevated, is 18·02, the highest of all. The eastern group has the high ratio of 12·73, which contrasts strongly with those for the west coast. Yorkshire and the four northern counties, extending from the east to the west coast, and with much high land, have ratios of 11·39 and 10·38 respectively.

Taking the whole period deaths occurred in every month, but they were most frequent in June and July, and somewhat less so in August—in these three months 75·5 per cent. of the whole took place; in 1872, even when there were 46 killed by this cause, 39 of them were in these three months, and seven only in April, May, and September.

PLYMOUTH AND THE ELECTRIC LIGHT.

AT the last sitting of the Plymouth Town Council, Mr. BURNARD drew attention to the recent visit of an eminent electrical engineer, who had interviewed several of the leading inhabitants of the town, and placed the subject of electric lighting before them in such a manner as to claim their careful attention, and create a desire to see his scheme, if possible, carried out. This gentleman was, he said, willing to initiate an installation, but he desired to do so in full accord with the Corporation, to whom he would be willing, when the success of the undertaking was fairly apparent, to hand over the works on fair and equitable terms. It was proposed to ask for permission to lay underground wires in different parts of the town, but this would be done chiefly in back lanes. When, however, it was found absolutely necessary to utilise front roads, the engineer could easily overcome the difficulty by going under the kerbs only to the depth of one foot. The system was working most successfully at Eastbourne and Brighton, and he understood that the engineer was in negotiation with the authorities at Birmingham, with a view to its installation there. The engineer was present, and would answer any questions it might be thought desirable to submit.

Mr. HOWLAND expressed satisfaction at the display of a spirit of enterprise which might lead to the introduction of the electric light into the town. At present the Hoe and many other places were in comparative darkness.

The TOWN CLERK, in reply to a question, said that the Electric Lighting Committee of the Corporation had not been re-elected.

No action was taken in reference to the matter, but it was intimated that a resolution might be put on a future agenda paper.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"Underground conduits and electrical conductors." By JOHN B. VERITY (member).

My object in bringing this subject before you this evening is to promote an interchange of opinion and experience concerning one of the few remaining problems connected with the general distribution of electricity in our cities. Since I began to write this paper on my return from America, much information has appeared in the electrical press, and the close attention now being paid to the matter in America is equalled by a like spirit of inquiry here. The outcry against overhead wires has been gaining in force, and although the numerous objections urged are devoid of solid grounds, there is a general feeling that any considerable extension of overhead cables for electric lighting is impossible, both on account of the difficulty, and no inconsiderable expense, in procuring wayleaves, and also the attitude taken up by the Board of Trade and others to put a stop to them. Overhead wires in this country may therefore be simply considered as a temporary measure to admit of the electric supply companies getting to work, and permitted only on the distinct pledge of the removal of such wires within a certain period.

The time allowed for the execution of underground works in provisional orders and licenses, although as long a period as could be obtained, is all too short, and a thorough discussion of the subject at the present time, in its numerous aspects, is highly advisable to enable it to be afterwards promptly and adequately dealt with.

In three months we may reasonably conceive that certain electric supply companies will be under legal obligations to at once face the problem of putting high tension electric conductors underground. It will be no petty attempt narrowed down to a small area, but in two special instances the undertaking is proposed to be carried out on a large scale by companies of adequate financial resources, and with supply stations already erected or in process of erection.

"Is failure probable?" may seem a singular question to put here, but it is a necessary one leading up to the various difficulties to be encountered, and in view of the alarmist statements at the recent Electrical Convention in Chicago, one that deserves prominence. Mr. Lynch's paper giving the results of the working of underground cables, and which was practically the only part of the meeting reported in the English papers, showed but one side of the case, and from the discussion following it much was to be learned. Many of the companies operating underground cables had from some cause or other not given their opinions, and the failures alluded to were in several instances traced to defective conduits, insufficiency of insulation, poor insulation, imperfect jointing, and cheap work. Cheap work has damned electrical enterprise before now, and it behoves us all to guard against a recurrence of it. Anything also on the subject of conduits and underground electric conductors emanating from American electricians has to be carefully sifted, as not even are our Unionists and Home Rulers more defined than certain "overhead" and "underground" men in America, The overhead men accuse all the underground men of being interested in some of the dozen forms of conduits put forth, the underground men retaliate by saying, "You don't want to go underground," and "You boldly say we cannot go underground."

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* Abstract of paper read before the Meteorological Society April 17th.

In England we stand on a different footing altogether; if much more electric lighting work is to be done we must go underground, and having recognised that, how can it best be done? The necessity and best form of conduits are the first points for discussion.

The successful working of a system of underground electrical cables in a city must be linked to an arrangement of ducts, as the impossibility without such, of getting at the cables for repairs, inspection, tapping and alterations is evident. Even if the local authorities remained quiescent during any continual disturbance of our streets on account of electrical conductors, commercial interest must prevent such occurring. The expense of opening up a crowded thoroughfare to lay underground cables is in many cases as great as the cost of whatever is being laid, while by using a duct this expense once incurred should not be again necessary. Again, if the cable be laid in the ground without a duct, it is necessary to armour it, and lay it down at first equal to all possible requirements, otherwise any extension of the lighting beyond the capacity of the cable would necessitate a repetition of the whole original work. In this case the first cost of such a large cable would be nearly as great as the smaller cable and duct together. Finally, the life of the best cable for high tension currents cannot at the present be predicted, and this, together with the other reasons, undoubtedly prove that a conduit with a drawing in and out system is eminently desirable.

An ideal system for underground work is a brick subway, well drained and ventilated, and of sufficient size to permit of a man working in it; failing this Utopian arrangement, what comes next best? In New York, where the matter has been placed in the hands of a Board of Electrical Control, they start out by saying that a conduit or subway for electrical conductors is nothing more than a mechanical protection for the wires within it, and a convenience for placing or putting them underground. In their experience of three years the Board of Electrical Control have naturally tried and abandoned many conduits. In a room of the Telephone Building, New York, occupied by the Subway Construction Corporation, there is a heap of experience—experience gained at no little cost—that it would be of advantage for engineers, who lightly propose undertaking such work, to see and meditate on. Wooden conduit, bitumen conduits, asphalte conduits, earthenware conduits, samples of underground conductors, all are here in what is termed the museum, and afford a collection of failures most instructive as to *what not to do*.

In many instances, however, the conditions there would not apply to England. At present we have no system of steam-heating with leaky pipes, causing trouble wherever they go. Again, here we have not those great extremes of heat and cold, the frost compelling conduits to be laid at an average depth of four feet, and the heat causing various troubles with asphalte and bitumen conduits.

At the same time from the numbers of miles of conduits laid down there should be something to learn, and I, therefore, propose instancing some of the more important conduits known in America and elsewhere.

Conduits are divided into two classes—the so-called solid conduit and the hollow conduit. Solid conduits are useless considering here, as they practically consist of cables bedded in asphalte or bitumen, which means ripping up the ground, and breaking the enclosing mass if alterations are required. With hollow conduits the difficulties to be encountered seem to be to provide a smooth channel with convenience for drawing in and out to prevent explosions through accumulation of gas, and to keep them reasonably dry and water-tight.

In the discussion at Chicago it was stated that in one instance it was necessary to keep a blower going to ventilate an iron conduit, while several authorities appear to consider it advisable on dry days to take off the manhole covers. Accidents have, of course, occurred from conduit explosions, and the engineer of the United States Electric Lighting Company instances one where the manhole covers of the conduit were blown over the roof of a four-storeyed building. But in England again, the work done by the gas companies is far better, and the leakage in our streets is not in any way to be compared with the quantity of illuminating gas which wanders fancy free through the soil of many of the cities in the States.

It appears desirable that conduits should be ventilated, and the form adopted where possible is to ventilate them by means of a pipe running into the base or up the interior of the street lampposts. With regard to keeping them water-tight, this is another constructional question, surely capable of being properly dealt with.

Many of the complaints of leaky conduits and ultimate failure of cables I trace back to the Dorsett conduit.

[Mr. Verity here described the Dorsett, the creosoted wood, the Callender bitumen, the Lake, the Doulton, the Hurlbut, and his own, which is described as follows:—Mr. B. Verity's conduit. This is a system of glazed stoneware clay conduit with separate channel for each conductor. The double cone piece being inserted before the jointing material is run in, the special object of this conduit is to enable bare conductors to be used insulated only at the manholes, or where they are likely to be handled. Experiments have proved this form to be capable of standing almost anything mechanically when laid on a fairly good bottom. Mr. Verity has also patented a system of glass tubes in iron pipes for the same purpose.]

Pipes of glazed earthenware with several ducts form a good mechanical protection, being capable of resisting considerable crushing pressure, while the glazing both inside and outside provides also, under certain conditions, a first class electrical protection. If it be desirable that the conduit should be formed of a non-conductor, then nothing could be better than such glazed earthenware, which also is of no great cost. The difficulty of maintaining good joints with earthenware pipes has been referred to some time ago in connection with conduits for telegraph purposes, several instances having been given by Mr. Preece and others, of roots of trees, branches, and other vegetation having made their way through the joints. Is this capable of being overcome by a flexible joint, which should at any rate prevent joints giving through expansion and contraction?

The great disadvantage, however, to the use of earthenware pipes in many places in a city like London is the amount of space required for them; in fact, the difficulty of laying any conduit at all in some of our streets will be found simply enormous.

As a mechanical protection only, it is immaterial whether the conduit be a non-conductor or not. The simplest form of such a duct is, of course, an iron pipe, and the Western Union Telegraph Company, among others, have laid cast iron pipes of 4 inches and 5 inches diameter, with manholes at a distance of about 450 feet apart. In the majority of cases, however, the plan has been to lay a number of separate iron pipes in a concrete bed, by which arrangement the pipes can be crowded, or curved, or kept apart, as may best overcome any difficulties or obstacles met with underground. For instance, four pipes may be laid on the same level in two layers, or where only a narrow excavation can be made, the pipes can be curved round so that two pipes are abreast in four layers. In this way the trenching is often materially diminished. Screw jointed, asphalted, wrought iron pipes of two or three inches diameter, laid in hydraulic cement concrete, are said to prevent the greatest tightness of duct against gas and water, together with the greatest strength.

Cement-lined sheet iron pipes, however, possess some advantages, such, for instance, as smooth interiors, and the advantage of an iron enclosure, without the cable being brought into contact with it, and on the sheet iron being eaten away, the cement still retains the pipe form. Zinc tubes again have been used, but are liable to be dented in, and asphalted concrete is often preferred to hydraulic cement concrete.

Whatever system of pipes be used, it is important that they should have smooth interiors and close joints, and every conduit of whatever kind must be thoroughly well bedded, so as not to be liable to displacement from above.

[Mr. Verity then went on to describe the Chenoweth, the Johnstone Iron, the Irish, and Mr. J. E. H. Gordon's system as used by the Metropolitan Electric Supply Company, in which the cables are drawn into an iron pipe, and smaller iron pipes are led from the house junction boxes to carry the wires for house lighting. Testing boxes of a larger size, and built of brick, are provided at intervals.]

It is generally admitted that an important point in underground work is good manholes. Mr. W. D. Sargent, in a paper read before the National Telephone Association, 1888, said that within reasonable limits it is almost impossible to get these manholes or working chambers too large, and that they have been compelled in many instances to rebuild and enlarge the manholes at first designed.

There is no doubt they must be of good size for convenience of drawing in and out, which is often a difficult matter, especially with lead-covered cables. In one instance, in Chicago, the manholes are built in octagon shape, in brick and cement, about 4 feet by 4 feet, being made air-tight with screw head and rubber gasket, and testing boxes placed in them, so that troubles can be readily located, faulty wires drawn out, and good ones put in. In other cases the man-holes vary from 3 feet 6 inches to 6 feet deep, with iron curbs and tops, and cement bottoms, and the covers made practically tight against water, many of the lids draining the water from the edge and collecting it in the centre, thus diminishing the liability to leakage at the gasket. With the Johnstone and the Irish conduits, it is not necessary to provide for house connections, as the alteration can be made at any time afterwards when an application for light is received. But, as a rule, hand distributing boxes, made of cast-iron with screw-head and rubber gasket, are fixed one between every two houses, and after jointing, the boxes are often filled with bituminous or insulating compound. In the cement lined pipe conduit system one pipe is occasionally placed at the top for the house distribution and connections made with the mains at the man-holes. As to the frequency of these latter, much depends on the alignment of the conduit, at angles or changes of grade small man-holes are necessary.

A combination curb and gutter conduit is worth notice. The curb and gutter is made of fine concrete, one part of Portland cement, ten parts clean sharp sand, and three parts of broken stone, and the exposed surfaces coated with a granilitic mixture 1¼ in. thick, such as is now used for some of our London pavements. A conduit for electrical conductors of any reasonable size can be formed as shown in the inner angle of the curb with handholes from above closed with iron covers at intervals.

It has been suggested some time ago that the curb stones should be removed from busy thoroughfares and replaced with a hollow curb edged with cast steel, and the suggestion may bear fruit in the future.

As I still have to deal with Electrical conductors, I cannot here refer to the general cost of laying conduits, as at one time I proposed doing. The principal cost, however, of laying them is in making good, and this depends on the material of the road, the cheapest being macadam (varying from 5s. per square yard), whereas asphalte would be nearer 20s. per square yard.

The difficulty of laying any form of conduit in some of our London streets must, as I have already said, be very great. The last comer will of course feel this the most, and although the Hydraulic Engineering Company may have recently had much trouble to find room for their pipes, the Electric Supply Companies again will have an easier task than the Telephone Company, who are putting off the evil day.

As to what form of conduit is most suitable for London and our provincial cities there will be differences of opinion, but I trust the discussion following will narrow it down to a small issue, upon which such work can be undertaken with a tolerable surety of its lasting success.

There is really sufficient subject matter for a paper on conduits alone, and in taking up the question of underground conductors, I propose to chiefly restrict myself to a consideration of conductors for high tension electric lighting circuits.

With regard, also, to underground conductors for low tension work, I feel that the Edison system as at present laid down, is thoroughly capable of filling all the requirements of house-to-house distribution. Many companies in the States and elsewhere are using it, and at the down-town station in New York it has been at work for the past six years successfully. In the recent discussion on Prof. Forbes's paper several points of interest concerning the Edison underground conductors were explained, which it would be unnecessary for me here to repeat. A full description of the latest developments of this system, with samples of the improved form of conductors, &c., are now on the ocean, and in the event of it being possible to provide another evening for a continued discussion of this paper, I shall be most happy to show and explain them.

Everyone must acknowledge the foresight shown in devising such a complete system of underground mains so long ago, and which, in spite of the all-round developments of electrical engineering not only holds its own, but is still far ahead in completeness ot any system for low tension underground work. The Westinghouse Company have, I understand, acquired the rights for Great Britain, and, presumably, will use it in connection with large transformers for sub-centres. It may be also interesting to note that Messrs. Siemens have made *concentric* three-wire cables, which are being successfully used at Elberfeld, Geneva, and Mulhausen, and they state that the troubles from what would appear very complicated jointing have been satisfactorily overcome.

It is underground conductors for high tension currents that I propose now to deal with. A principal point for consideration is the necessity or not for lead sheathing where conduits or ducts are employed.

As to the durability of lead much absurdity has been talked. It is notorious that lead pipes have been in the ground under all manner of conditions, and at the end of long periods are still intact. There are no doubt certain clayey soils where lead has not much lasting power, but the lead may be materially preserved by coating it with coal tar, well tapeing it, and again soaking it in the coal tar or some such protective composition. Again, as Dr. W. von Siemens recently said in reply to Prof. Forbes's paper, the manner in which the lead covering is generally put on to such cables, viz., by heating the lead to the point of melting, and forming it in this condition round the cable, while passing through the press, gives no guarantee of a uniform thickness, and it is very difficult to obtain a tube through which damp, in course of time, will not find an entrance, as air bubbles and impurities in the lead are liable to make the covering porous. A far better result is obtained by covering the insulated cable with a cold drawn lead tube, as the air which might still be contained in the lead block is compressed to a minimum.

A theory as to partial wasting of lead covering on cables is that it may occur from acid being present in the jute or fibrous insulation, or again that the petroleum residuums may set up a chemical action on the lead; but there has not been much evidence on these points. Manufacturers of lead-covered cables have admittedly put on too thin a coating of lead in their earlier days, this has been gradually increased, and with proper conditions and precautions there should not be much fear of its durability.

Iron armoured lead-covered cables are not necessary if an effective system of conduits is used for mechanical protection In Berlin, where such cables are employed, they are simply laid in a trench in the ground, and consequently require to be thoroughly protected from mechanical injury. Lead alone is not sufficient.

Dr. Werner V. Siemens said in his recent paper, that long years of experience had taught him that although covered with hemp or jute it requires further protection to render it secure against mechanical injury whether by men or animals, as even rats eat their way through. Such protection is afforded by a double spiral of sheet iron, which again is made secure against oxydation by asphalting or galvanising, or by another cover of tarred hemp or jute. Such armouring as this is quite needless with a well constructed conduit, but as to whether galvanic action takes place Dr. Siemens has undoubtedly shown by his firm's experience that with a substantial layer of tarred or asphalted jute between the metals it does not occur. This form of armoured cable was laid at Munich for lighting the theatre, and after nearly five years in the ground is as perfect as at first. At other central stations at Elberfeld, Darmstadt, Geneva, Salzburg, Lyons, The Hague, St. Petersburg, their iron armoured lead-covered cables prove that constructed in this way there need be no fear of galvanic action at any rate.

Lead sheathing may be made durable, but the actual necessity of it where a conduit is used is quite another matter, and a consideration of the two principal divisions of insulating material has considerable bearing on this point.

Of the fibrous and the homogeneous the latter seems to present some important advantages for insulating high tension cables. For instance, vulcanised rubber is flexible and tough, and affords a continuous and homogeneous covering which should be superior to a fibrous covering. Vulcanised rubber cables are at times sheathed with lead for mechanical protection, but such is not necessary if laid under good mechanical conditions, and Dr. Lant Carpenter recently said that the sulphur in the vulcanised rubber would attack the lead in the same way it would copper. If, as is stated by many English cable manufacturers, compound vulcanised rubber will well withstand the deteriorating effects of damp and gases, then, the mechanical protection being afforded by a conduit, the necessity of lead as a protector is no longer of importance. It is true unprotected vulcanised rubber cables in conduits have failed in the States, but the competition among electric light companies in America is notorious, and the question as to the maintenance of cables is not considered so much as their relative first cost. The object of the American cable manufacturers, naturally suiting their market, has been to make cables with a cheap form of vulcanised rubber insulation to compete with the jute insulated cables there, and which are cheaper. The vulcanised rubber evidently was not properly prepared as it should be to permanently counteract the deteriorating effects of damp and gases by reason of the expense.

All those acquainted with the rudiments of rubber manufacture must be aware of the enormous difference in quality of different vulcanised rubbers. With Para rubber at 3s. per lb. and the desire to sell it at a shilling, all manner of substitutes and compounds have been introduced. While thoroughly appreciating the energy and genius of American electricians, we can confidently say that cables manufactured in this country are greatly superior to those made in the United States; and as a basis for this belief we have the fact that most of the cables for high tension distribution in the States have proved faulty, according to their own admittance, while there is undoubted evidence of the successful working of many vulcanised rubber and jute insulated cables in this country and in Europe, made by English manufacturers. The statement is made by the Silvertown Company, Messrs. Henley & Co., and others, that they are absolutely prepared to guarantee for a term of years their vulcanised rubber cables unprotected by lead, even if laid in damp and leaky conduits, provided there is suitable mechanical protection against injury and that the cables are laid under competent supervision.

With regard to *fibrous* insulating material it is alleged that it has the defect of opening cracks when bent. If this be the case it would become more pronounced when the material is soaked in resinous compound, and perhaps less so when petroleum residuums are used, such as for instance in Ozite, Kerite, Bitite, &c. If cracks are likely to be formed when the cable is bent or twisted about, air paths would be opened up for disruptive discharges.

In the working directions given for the laying of one of the principal lead covered cables in the States, it says "the fibrous material being superdried will readily absorb and retain moisture from the air, and cables showing an insulation resistance of thousands of megohms when first made may after exposure of a small part of the core to moist air for a few hours show a great falling off of insulation resistance." Instructions are therefore given as to carefully sealing the ends of the cable when laying. Again the splicers' hands are cautioned to be kept "perfectly dry and free from perspiration, as a little moisture communicated to the insulation may result in vastly lowering the insulation resistance." These remarks written by manufacturers of such cables show the readiness with which such fibrous insulation may deteriorate under conditions likely to occur even if there be the most careful supervision of the men laying the cables. It is acknowledged to be absolutely necessary to cover jute or cotton insulated cables with lead, and it is in this fact that the weakness of such cables seems to lie, as the moisture and gas resisting portion is the lead absolutely, the jute insulation being of little value in this respect. Inasmuch as the majority of underground cables in the States are insulated with such jute or cotton soaked in some compound it will be at once understood why lead covered cables are considered in America as the only means for successfully carrying out such underground cable work, especially when the cables are liable to be laid in leaky conduits. It is right to say that apparently few troubles have been experienced in Europe with underground conductors insulated with fibrous material. Messrs. Siemens and Halske, who use a jute covered cable, but manufactured in a different way both as regards the impregnating of the jute and the method of cold drawn lead sheathing, have a successful record, not only for low tension cables, but for the various concentric cables supplied to Messrs. Ganz & Co., of Buda Pesth, for 2,000 volt alternating currents. They assert that the troubles experienced with American underground cables, whether jute or rubber insulated, are comparatively unknown. The question between what I broadly term lead sheathed jute, or well compounded vulcanised rubber seems to me the momentous one, and as usual each one has certain claims.

It is well known that the cost of jute insulated cables is less than that of high-class vulcanised rubber insulation, but this would have little weight unless they can be proved in every respect equal to vulcanised rubber. In a comparison of the different costs of such insulation, vulcanised rubber appears to be about 25 per cent. more for approximately the same insulation resistance. In making this comparison I took the cost of a vulcanised rubber cable, insulated with one layer of so-called pure, and two coatings of vulcanised rubber, taped, braided and coated with preservative compound, but not covered with lead, as this is a superfluity, the cable being watertight without this addition. The jute insulated cable I took as cased with lead and protected again by a covering of tarred jute yarn compounded.

After the relative cost comes the question of jointing, and as this is one of the most vulnerable points in any cable it is of vital importance that the joints should be made as good as any other part. With vulcanised rubber cables the joints must be vulcanised, and first-class rubber men who would make such joints speedily should be on the working staff. With lead-covered cables a plumber would have to be employed, and I am informed by those who have had experience with both forms of cables that the vulcanising is preferable to the plumbing.

Vulcanised rubber cables are certainly easier to handle, being more flexible, ductile, and lighter, and this is of importance in view of the difficulties occurring in drawing cables in and out of a conduit.

Again, when lead-covered cables are coiled round a drum the part nearest the centre becomes compressed, while the outer portion is extended; on uncoiling the cable the opposite effect is produced, the parts before compressed being now pulled out, and the extended portion compressed. This is trying to an inelastic substance like lead, the more so when, unlike an empty lead pipe for water, it is filled with an insulated cable. It is quite conceivable that the surface of the lead may be slightly broken up, particularly when the method employed is to cover the lead hot round the cable, and although no cracks may be visible to the eye, gas and moisture might be apt to find their way in very quickly, with corresponding deterioration of the insulation.

Next, as to whether jute or vulcanised rubber is better suited for insulating high tension alternating cables no opinion can yet be given. It is well known that on submarine cables working with reversed currents, it is usual at times to give the cable a rest. This necessity may be due to the action of the reversed current on the insulation, and it would be interesting to know how the much more powerful currents and rapid reversals of an electric light circuit will affect the insulation of a cable after carrying such currents for a considerable period. In some interesting papers, published last year by Mr. Addenbrooke, he came to the conclusion that a high tension alternating current should have less effect on any dielectric than a continuous current of the same potential. He argued that, owing to the rapid alterations, there would not be sufficient time to fully charge the dielectric, as, before this could occur, the next charge would sweep out the former charge, partially recharging it in the opposite direction. But it would certainly appear that such an action as this on a dielectric would be far more injurious than for it to be fully charged as with a continuous current.

From a careful review of what I have seen in the States and elsewhere, I must confess that my own feeling is in favour of a cable insulated with thoroughly good vulcanised rubber for high tension work, and I was interested to hear Sir William Thomson say on Monday at the Board of Trade enquiry that if high tension conductors were protected in an iron pipe a lead sheathing to them was not essential.

Those acquainted with the present manufacture of rubber cables know that pure rubber proper is not used for their insulation. However good the rubber may be, there is always a certain amount of impurity and oils which will set up decomposition sooner or later. This is overcome by slightly vulcanising the rubber, but so that there shall be no surplus sulphur to attack the copper. In the high-class cables now made by the Silvertown Company and others the practice is to put next the conductor after cotton twist a substantial coating of pure India-rubber, slightly vulcanised, upon this a coating of zinc rubber, with vulcanising materials, and covering this, a compound vulcanised rubber of great resisting qualities to damp and gases. The zinc rubber takes up the surplus vulcanising material of its two outer coverings, so that the copper cable is not injured by the sulphur used in the process. Such an insulation as this is as good as could possibly be desired for any high tension currents, and is absolutely perfect so long as the covering is continuous, and as the whole of the materials are treated at a temperature of 400°, any rise in temperature of the conductor due to accidental overloading will not injure the insulation. With regard to the outer protection of the compound vulcanised rubber, there may be still scope for further improvement, and, for, instance, in the cables recently made by Silvertown Company for the London Electric Supply Corporation two braidings of asphalted tape have been used, and this is found to be satisfactory. Among the instances where vulcanised rubber cables have stood stringent tests has been at Eastbourne, where Mr. Lowrie has used Silvertown cables laid in iron pipes for two years, and states they are still in perfect working order. He has also put down there a length of Fowler's Tatham lead covered cable for continuous current high tension work, the fibrous insulation being well wrapped round several times with tape. This has also been working successfully, and in the House-to-House Company's station he proposes to try each method of insulation on different circuits, although the advantages of handling the India-rubber cables are in their favour.

The Silvertown Company have five miles of vulcanised India-rubber insulated cable sheathed with iron wires at Brussels, with 1,400 volts constant current. This was laid in the sewers two years ago, and is now quite satisfactory.

This company have also supplied two miles of such cable, but with asphalted tape on the outside to the London Electric Supply Corporation, with 2,400 volts alternating current, the conductors being laid in an iron pipe.

There are also samples on the table of a piece of Messrs. Henley's vulcanised rubber cable that has been in use overhead for 10 years.

A difficulty with underground conductors in the States seems to be disruptive discharges, and I trust the discussion may bring forth information on this subject. Owing to the frequent puncturing of the insulation, attended with pinholes in the lead covering, Mr. Acheson, the Waring Company's able electrician, and whom I desire heartily to thank, turned his attention to the matter, as the pinholes by admitting moisture defeated the object of the lead-sheathing, and proved fatal to the life of the cable.

Mr. Acheson's theory is that the static electricity generated in the cable after a time punctures the dielectric by discharging itself between the copper conductor and the lead sheathing.

To show the exceedingly minute path necessary for a discharge it may not be out of place to quote Mr. Acheson's experiment. A plate of glass about one-tenth of an inch thick was broken in two pieces, and the two parts immediately fitted to their former position and clamped, the restored plate was placed between two discharging points, and so long as the points were over the solid glass no discharge was obtained, but upon removing it so that the line joining the points would lie in the plane of the fracture, a discharge immediately occurred.

A possible cause of a disruptive discharge might be that on high tension circuits of great self-induction, as, for instance, on arc lighting circuits, where lamp coils form part of the line, the induced current on breaking the circuit is very violent, and in preference to discharging through the line, and consequently the lamp coils, it gets away by rupturing the weak insulation and passing through to the outer earthed casing.

The exemption from such trouble is credited by many entirely to a thicker insulation being used, and in calculating the insulation for a high tension cable, it should be made sufficient to withstand a disruptive discharge of this nature and tested accordingly. For instance, owing to the almost daily occurrence of burn-outs with some cables in Chicago with $\frac{3}{32}$nds insulation laid in November, 1887, the four miles laid in December, 1887, had $\frac{4}{32}$nds insulation, and the two miles laid early in March, 1888, have $\frac{6}{32}$nds insulation. Careful experimental work is essential before the sufficiency of insulation for such underground cables can be accurately determined, and our leading cable manufacturers naturally keep the results of such experiments to themselves.

Concentric cables, although so extensively used by Messrs. Ganz, of Buda-Pesth, in their stations, do not appear as yet to have met with favour in the States. It is, of course, undesirable to use ordinary lead-covered cables for alternating currents, both on account of the loss from induced currents in the lead sheathing, and the annoyance to workmen handling them. If, for instance, while handling a conductor conveying such a current the lead covering be insulated to any extent on each side of them, the workmen would receive the induced currents through their bodies. Again, when the two legs of an alternating current are in separate cables, and the cables laid in insulating materials, any chance contact or connection between the leads might cause the induced currents to pass backwards and forwards at these points, thus tending to cut away the lead covering as the result of any sparking at poor contacts between the two leads. The Waring Anti Induction Cable, with both wires enclosed in one sheathing, is well known, and in this the currents induced by both wires being equal in power and opposite in direction, tends to neutralise one another.

Mr. Ferranti, by employing concentric cables for conveying the high-tension currents from Deptford Station, has brought such cables into prominent notice in England. A concentric cable is obviously the best on theoretical grounds for the elimination of induced currents, as their reaction upon one another is necessarily strongest in the axis of the current. The question as to the necessity of insulating the outer conductor of the concentric cable has recently had considerable attention given to it by Mr. Preece on behalf of the Post Office authorities, and as a result of his experiments, they evidently must be so insulated. All the concentric cables made by Messrs. Siemens and Halske for Messrs. Ganz & Co. are of the usual stranded wire form, and the outside conductor, after being well insulated with jute, is covered with a cold-drawn lead tube, having an outer iron armouring, as previously described. These cables have been successfuly used in Rome, Tivoli, Turin, and Milan, in each case carrying a potential of 2,000 volts.

The difficulty of making satisfactory joints with concentric cables must be to a certain extent against them, as it is impossible to see what has been done inside. Messrs. Siemens say that it can be readily accomplished. The Silvertown Company have made several forms of concentric cables, highly insulated with vulcanized rubber, with considerable success for ship work, and they also have an arrangement for constructing the joints.

As to whether concentric cables will be largely used in this country much depends upon the system of distribution employed. For long lengths of cable used as feeders to sub-centres, or to systems of distributing mains, they would be of considerable advantage, as no joints would be required *en route*, but in house to house distribution with frequent joints a pair of separate cables near to each other would appear the more easy to handle and the more practicable to operate. In summing up this matter it would appear that the relative advantages are as follows:—1st. The greater convenience of making joints on separate leads as against the trouble involved with concentric cables. 2nd. As regards the relative cost between two separate cables and concentric cables with the same insulation resistance, vulcanised rubber unsheathed concentric cables with outside insulation are dearer, but with jute insulation for concentric cables and lead sheathing they are cheaper 3rd. There remains the increased efficiency on an extensive system of alternating currents by the use of the concentric form.

With regard to the second point, the figures showing these are:—

For vulcanised rubber, two Silvertown $\frac{19}{18}$ conductors insulated to 5,000 megohms at 60° Fah., taped and braided over all, specially prepared for underground work, £255 per mile each = £510.

A concentric conductor of equivalent capacity, the internal conductor insulated to 5,000 megohms, as above, but the outer to 3,000 only = £900, being a difference against the concentric conductor of £390 per mile.

If the outer insulation is reduced to 1,500 megohms the price falls to £630 per mile, which is £120 above the cost of separate leads.

On the other hand, for Messrs. Siemens's specially prepared jute insulation two single conductors of same insulation at £220 per mile each = £440.

A concentric conductor of equivalent capacity, the outside insulated to 900 megohms, lead sheathed, taped and asphalted, £363 per mile.

All cables for high tension currents should be well tested before leaving the factory. In other branches of engineering the engineer would not think of receiving his steam or hydraulic pipes without first seeing them tested to, say, over twice their working pressure; it is not sufficient for him to see simply that they will hold water or steam, but he must satisfy himself that they are strong enough for the pressure they have to carry. In the same way the electrical conductors which have to transmit energy, much as the steam and hydraulic pipes do, should be tested to twice their working pressure. With the outside well earthed the current should be allowed to traverse the condnctor a considerable time, and an electrical test taken afterwards for insulation. With electrical cables for underground work passed in this way, and satisfactory in other respects, there should be no fear of breakdowns under ordinary conditions.

In dealing with a subject of such wide extent and great importance as this it is impossible to do justice to all the workers in the field. I have left out much that may be considered interesting and important, but the difficulty has been, with the mass of information on the subject, what to put in and what to leave out. Doubtless there are many instances of cables and conduits having been successfully at work which have not been mentioned in this paper, and I hope such information will be forthcoming. If the discussion following be the means of clearing up some of the doubtful points surrounding the subject of underground electrical work, and of demonstrating the direction in which successful work should be undertaken, the object of this paper will be fully accomplished.

Physical Society, April 13th, 1889.

Prof. REINOLD, President, in the Chair.

MESSRS. J. E. DOWSON, W. M. Mordey, E. A. O'Keefe, C. Priest, A. Siemens, and W. B. Willans were elected members.

Mr. SHELFORD BIDWELL, F.R.S., showed "A Lecture Experiment Illustrating the Effect of Heat on the Magnetic Susceptibility of Nickel," and "An Experiment Showing an Effect of Light on Magnetism." In the first experiment a piece of nickel was attached to one side of a copper pendulum bob, which was held out of the vertical by bringing the nickel in contact with a fixed magnet. On placing a spirit lamp flame below the nickel the bob was (after a short time) released, and oscillated until the nickel had cooled, when it was again attracted and the operation repeated itself. The second experiment had been recently shown before the Royal Society. One end of an iron bar which had been magnetised and then demagnetised was placed near a magnetometer needle. On directing a beam of light on the bar an immediate deflection of the needle resulted, and on cutting off the light the needle promptly returned to near its initial position. The direction of magnetisation induced by the light is the same as the previous magnetisation, and the bar seems to be in an unstable magnetic state. That the effect is due to light and not to heat the author thinks is rendered probable by the suddenness of the action.

The PRESIDENT said he had tried the experiment himself and failed to get any effect; but after seeing the arrangement of apparatus used, he believed his non-success due to the comparatively great distance between his bar and needle.

A MEMBER asked if the results were different for different coloured rays, and

Prof. S. P. THOMPSON enquired whether the magnitude of the effect varied with the intensity of illumination as in selenium, and also if any change was produced by altering the direction of vibration of the incident light.

Mr. G. M. WHIPPLE wished to know whether any difference was produced by blackening the bars, and as bearing somewhat on the same subject mentioned an induction magnetometer in which an iron bar used was demagnetised by plunging in hot water. The results obtained were very irregular after the first magnetisation, and this may have been due to the instability shown to exist by Mr. Bidwell's experiment.

In reply, Mr. BIDWELL said red light produces most effect, and blackening the bar makes the action much slower. As regards selenium the character of the effect is similar, but he believes the causes to be different. Polarised light produces no change.

In answer to Prof. HERSCHELL, he said that any part of the bar is sensitive to light, and showed that illuminating both sides of the bar increased the effect.

Mr. G. M. WHIPPLE read a "Note on the Dark Flash seen in some Lightning Photographs." After expressing his dissent from the explanations offered in the report of the Lightning Flash Committee of the Meteorological Society and Prof. Stokes respecting "Ribbon Lightning" and "Dark Flashes," the author described some experiments he had made on the subject. Ribbon lightning he conceived to be an effect produced by taking the photographs through windows, and to test this, lines on a blackboard were photographed—first, direct; second, through good plate-glass placed obliquely; and, third, through window glass, the result being that double, triple, and ribbon flashes were closely imitated. As regards "Dark Flashes," the author believes the appearance to be due to the prints being taken in oblique light, and to be produced by successive reflection from the reduced silver forming the dark line on the negative and the upper surface of the glass of the negative.

Prof. PERRY suggested that this might be easily proved by examining a negative, the prints from which show the dark flash.

Mr. BAILY pointed out that if the explanation given were correct, the dark line should be parallel to the bright one, and this he understood was not always the case.

Mr. BOYS remarked that one dark flash exhibited minute wriggles not seen in the bright one, and

Mr. C. V. BURTON thought these might be due to irregularities in the upper surface of the negative.

Dr. GLADSTONE said he was not satisfied with Prof. Stokes's nitrous oxide explanation, but thought the phenomenon may be due to some kind of reversion. He also mentioned that a negative might probably be obtained from Mr. Shephard, of Westbourne Grove.

As regards "Multiple Flashes," Mr. BOYS said he had often seen seven or eight flashes traverse the same path in rapid succession.

On the motion of the PRESIDENT the discussion was adjourned until next meeting, when Mr. Whipple hopes to exhibit the negative referred to, together with photographs of his experimental dark flashes."

"On Quartz as an Insulator," by Mr. C. V. BOYS, F.R.S. In making quartz fibres, the author observed that the ends of fibres broken during the shooting process coiled up into screws, and projected themselves against anything brought in their vicinity. After a short time they released themselves and sprang back to their original position. This could be repeated indefinitely, and the only explanation he could think of was that the fibres were electrified. If so, then to exhibit such phenomena the insulating qualities of quartz must be very great, and experiments were shown to demonstrate this deduction. A small pair of charged gold leaves were suspended from a short quartz rod in a moistened atmosphere, and the deflection fell ¼ the original amount in about five hours. A clean glass rod under the same conditions would discharge the leaves in a few seconds. Dipping the quartz into water did not seem to diminish its insulating properties, and ordinary chemicals produce no permanent prejudicial effect. The author considers that quartz will be very useful in electrostatic apparatus, for the troublesome sulphuric acid may be dispensed with.

NEW PATENTS—1889.

5955. "Improved ceiling rose or connector for electrical circuits and for the suspension of electrical fittings." E. W. LANCASTER. Dated April 8.

5976. "An improved automatic electric alarm clock." A. LEYLAND. Dated April 8.

6021. "Improvements relating to dynamo-electric machines and electric motors." A. L. SHEPARD. Dated April 8.

6033. "Improvements in the art of transmitting articulated speech by the agency of electricity, without employing pulsatory, undulatory, or vibratory electric currents on the line." J. ABSTERDAM. Dated April 9. (*Complete.*)

6064. "Improvements relating to electro-magnets and to armatures for dynamo-electric machines or electric motors." H. H. Lake. (Communicated by E. Thomson, United States.) Dated April 9. (*Complete.*)

6104. "Improvements in the manufacture of filaments for incandescent electric lamps." H. H. Lake. (Communicated by J. B. Tibbits, United States.) Dated April 9.

6119. "Improvements in thermo-electric batteries." J. J. Shedlock and R. Mestern. Dated April 9. (*Complete.*)

6165. "An improved electrical apparatus for periodically ringing bells or sounding alarms, and registering the same." F. H. Berry. Dated April 10.

6171. "Improvements in means for regulating or controlling electric currents." C. R. Heap. Dated April 10.

6195. "Improved method of and means for constructing globes for incandescence electric lamps." G. H. Shepherd. Dated April 11.

6209. "An improved exciting liquid for use in electric batteries." E. Liebert. Dated April 11.

6231. "Improvements in apparatus for producing electro-magnetic action with small self and mutual induction." W. E. Ayrton, J. Perry and E. W. Smith. Dated April 12.

6284. "Improvements in electric cut-outs." H. N. Prentice. Dated April 12.

6285. "Improvements in dynamo-electric machines and electric motors." H. N. Prentice. Dated April 12.

6286. "Improvements in secondary batteries." D. Urquhart and W. Bates. Dated April 12.

6332. "Improvements in connection with electric fuses." W. H. Scott and Laurence, Paris and Scott, Limited. Dated April 13.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888

5922. "Improvements in connections, especially suitable for joining electric conductors." G. Stuart. Dated April 20. 6d. The connection consists of a screw and nut, the wires or other parts to be connected being clipped between the nut and a flange upon the screw. The nut is made hollow, and contains a spiral spring, one end of which presses against the nut whilst the other bears against a collar or cap fixed to the top of the screw. One end of the wire forming the spring is fixed to the nut and the other end to the cap, and before fixing the latter by rivetting or otherwise it is turned round so as to wind up the spring, which, therefore, tends to screw on the nut by reason both of its compression and of its being wound up as above described. The claims are 3 in number.

6400. "Improvements in electrical signalling, or alarm apparatus for domestic and other purposes." W. H. Dingle. Dated April 30. 8d. Relates to a combined portable electric bell and burglar alarm, and has for its object to provide apparatus which is compact, so that it can be readily transported from place to place, and which can be applied without difficulty. The claims are 5 in number.

7696. "Improved portable incandescent electric safety lamp." T. Coad. Dated May 25. 8d. Claim:—A portable electric lamp for miners, consisting of the combination of a suitable battery, and the base provided with contact points and fitted with a hermetically sealed glass envelope, within which is arranged a spring closing inlet air valve to enable the envelope to be charged with compressed air and retain same, an incandescent lamp holder electrically connected to one pole of the battery and having one of the connections for the lamp attached, and a diaphragm, having the other connection for the lamp attached or electrically connected thereto, normally not in circuit, but so as to complete the circuit on the depression of the diaphragm, all as described.

8354. "Improvements in the manufacture of depolarisers for electric batteries." M. Leclanche. Dated June 7. 6d. Claim:—In the manufacture of depolarisers for electric batteries the addition to and moulding with the depolarising body or mixture of a soluble material which is afterwards eliminated by dissolving it in water or which will be dissolved out by the battery liquid, whereby fine spaces or pores are produced in the depolarising body, substantially as and for the purpose set forth.

13778. "Improvements in telephone central station apparatus." T. N. Vail and J. A. Seely. Dated February 25. 11d. Is an improvement in the arrangement of telephone apparatus, whereby intercommunication between distant points is facilitated, while the space occupied and the expense of erecting and maintaining such apparatus are reduced. The claims are 9 in number.

14110. "Improvements in telephone central station apparatus." T. N. Vail and J. A. Seely. Dated March 1. 8d. Is an improvement in certain details of construction of switch-boards for use in telephone central stations. The claims are 5 in number.

14111. "Improvements in telephone exchange signalling apparatus." T. N. Vail and J. A. Seely. Dated March 1. 8d Is an improvement in the arrangement of apparatus for telephonic signalling between sub-station and central station, by which the inventors avoid the necessity for the use of special indicating devices to receive calls or requests from sub-stations, and they only use an annunciator for clearing out purposes. The claims are 3 in number.

15369. "Improvements in secondary batteries." P. A. Fichet and A. Nodon. Dated October 25. 6d. The electrodes are formed with pieces of agglomerated carbon, or with metallic pieces covered with an adherent and sufficiently thick layer of the active metal. The thickness of this layer is such as to be never completely dissolved, and in that way the metallic electrode on which the layer is applied being never bare undergoes no alteration. The claims are 8 in number.

17223. "Improvements relating to electric secondary batteries or accumulators and to the manufacture of electrodes therefor." L. Paget. Dated November 27. 8d. The first part of the invention relates to storage batteries in which the active material is applied to one of the electrodes, while the other electrode is of what is known as the Plante type, and its objects are: first, to obtain a porous positive electrode affording ready exit for the gases developed thereon, and an even circulation of the electrolyte through it. Second, to construct a negative electrode in such a manner that the supporting frame shall present a minimum amount of absorbent surface, and that the greater portion of the support for the active material shall not be directly exposed to the electrolyte, thereby preventing the development of hydrogen on the surface of the frame instead of the reduced lead and avoiding the developments of false electromotive force attained at the surface of the electrode or plate during the process of charging. A further object of this form of support is to more securely hold the active material. The claims are 31 in number.

17340. "Improvements in electro-depositing cells." P. M. Justice. (A communication from abroad by E. L. Smith, of Ansonia.) Dated November 28. 8d. Claim:—A vertical series of horizontal electro-depositing cells formed by horizontal plates of the metal to be deposited, separated and supported by insulated supports, and immersed in an electrolytic solution with screens interposed between the successive plates, substantially as described, whereby insoluble matters are arrested as they are liberated from the lower surface of the upper plate in each cell by the combined action of said solution and electric current.

17535. "An improvement in or addition to electrically operated combination apparatus for domestic use." L. M. Davis. Dated December 1. 8d. Claims:—1. The combination with an electrically operated apparatus for domestic use, consisting of a swing spirit lamp, a glow or incandescence lamp, a clock and alarm mechanism of a fire alarm, substantially as described and for the purposes set forth. 2. The fire alarm, for use with electrically operated combination apparatus for domestic use, constructed and arranged to operate as described and as shown.

17645. "Improvements in apparatus for indicating the completion of the charging of secondary galvanic batteries." S. C. C. Currie. Dated December 4. 8d. As soon as the accumulator or secondary battery becomes charged, the ebullition of the fluid of the same generates a spray or mist which settles upon or is absorbed into a strip of flannel, and as the fluid in such batteries is acidulated water, provides a path through or upon the surface of the same for the passage of an electric current, which thereupon operates an indicator. The claims are 8 in number.

17905. "An improved rotary dynamometer." J. Kasalovsky. Dated December 7. 6d. Consists in fitting fast and loose pulleys and analogous machinery, with resistance mechanism in such a manner that, by causing the loose pulley to drive the fast pulley, the amount of power applied thereto may be indicated and recorded. The claims are 3 in number.

18057. "Improvements in cut-out apparatus for electric lamps." P. M. Justice. (A communication from abroad by C. Heisler, of America.) Dated December 11. 8d. Relates to means for short-circuiting an electric lamp when the lamp fails to operate normally, and it consists in providing electro-magnetic and thermal devices which mutually co-operate in assuring the continuity of the line, and thereby promote the efficiency of the electric lighting system. The claims are 3 in nnmber.

18900. "Improvements in electric telegraphy." M. W. Dewey. Dated December 27. 8d. Claims:—1. The described telegraphic printing code consisting firstly in marks of different lengths, secondly in the arrangement in a row at right angles to the line of travel of the paper of the plurality of marks designating a single letter or character, thirdly in making the marks in each row of corresponding lengths, and fourthly distinguishing the different letters or characters from each other, both by the difference in the lengths of the marks and by the distances of the marks from the longitudinal edges of the paper, substantially as described and shown. 2. The improved system of electric telegraphy consisting essentially of multiplex lines, transmitting keys arranged to be operated by one operator at one end of said lines, and recording levers at the opposite end of the lines, and arranged with their markers in a row at right angles to the line of travel of the paper to print simultaneously side by side the several marks representing a letter or character, as set forth. 3. The combination of two duplex or quadruplex lines, manipulative keys arranged to be operated by one operator at one end of said lines, and recording levers at the opposite end of the lines and arranged with their markers in a row at right angles to the line of travel of the paper, substantially as described and shown for the purpose specified.

CORRESPONDENCE.

Problems and Conditions of Ocean Telegraphy.

Following on my previous letter, which you were good enough to insert in your journal, I will attempt, with a somewhat limited knowledge, an answer to one sentence in "Problems and Conditions of Ocean Telegraphy": "let us have some substantial proof of the success of the automatic grapnel and the patent grappling rope," which appeared in your editorial of April 5th.

I have followed with interest the working of these devices since they were invented and I am able to say that they have been employed by the inventors in the recovery of the Atlantic cables during the last six years in all important repairs, including all those in deep water and generally also those made in shallow water, to the exclusion of the use of the old form of grapnel. The working qualities and value of the grapnel are specially felt when heavy weather overtakes the operations such as would have entirely suspended all work with the ordinary grapnel in tow.

In a few words, the reasons, I believe, for this preference for the automatic grapnel are to be found in the following facts, viz., that the repairs are carried out with greater certainty, in much less time (thereby running less risk of storms and of having to make for the coast for coal) and the expenditure of new cable is not so great. The use of this grapnel is found to lessen the damage and displacement of the cable during dragging, it signals the hooking of the cable as soon as the latter is between the prongs, whilst it is lying in a slack undisturbed state on the bottom and it permits the raising to be commenced at the most favourable time and not after a delay of from 30 to 60 minutes after the hooking.

Cable engineers repairing with this grapnel are in the advantageous position of receiving the earliest news of the work at the bottom, whereas by the older method the information so much wanted comes later on when the cable is in tension or else it does not come at all.

The action of dragging causes the old form of grapnel to surge along the cable, rubbing off in its course the serving and protective compound and setting up corrosion; as it proceeds the cable is pulled out of the position in which it was laid until the strain that is set up is sufficiently great to act on the dynamometer, or, if by reason of age and decay, the cable is in too tender a state to withstand this strain, it breaks, unknown to the engineers on the ship, who are also in total ignorance that they have even had the cable on the prongs. The dragging for nothing continues for a time depending on the correctness of the position taken up and upon the vicinity of other cables, when not having found what they are in search of, a fresh position is made for further along the line and the cable probably loses a few more miles of its length and a few more pounds is added to the cost of repairs.

It seems to me that the employment of the old type of grapnel is an example of working blindfolded when at least partial sight might be obtained.

In the matter of hemp covered *versus* armoured cables I would refer to another editorial in the ELECTRICAL REVIEW of 15th December, 1883, on light *versus* heavy cables, from which more information may be obtained on this important subject. The opinion expressed in the concluding passages in these words, "the permanence of hemp can we believe be thoroughly assured under all conditions met with in the case of deep sea routes, even under circumstances which up to the present have proved unfavourable, and we are convinced that the feasibility of the general idea will have to be tested sooner or later as competition grows keener," is confirmed by the evidence that may be adduced from some specimens of tarred hemp that lie before me. These specimens were procured by Staff Commander Cole, R.N., and were taken from an old disused hawser submerged in Halifax harbour previous to 1851, the supposed date being 1813. There is no sign of any deterioration whatever in the appearance of yarns, but on contrary they retain the fresh rich brown colou recently made rope and they smell strongly of tar.

This specimen will, substantiated as to its ori help to dispel the notion that salt water gradu forces out the tar from the hemp, at least durin period of 30 years, and the argument follows tha after 30 years' exposure the tarred hemp is materially depreciated it will last a second 30 y in good condition. The hemp-eating insect had attacked this hawser during its long submergence, freedom from boring was apparently due to the tar.

In regard to the recovery of hemp covered cabl the allusion in the article to one of this type sunk the Mediterranean that would not stand raising, mi be put beside the more numerous examples of ironc cables that could not be recovered; the latter w made stronger and improved in other ways till th could be raised, and I see no reason to appreh failure from this cause with hemp.

The experienced men who designed the 50 knots hemp covered cable that were put into one of the Atlan sections last year and the board who sanctioned employment could hardly have been unmindful of t necessity of giving the cable sufficient strength th it might be raised.

E. W. Beckingsale.

April 16*th*, 1889.

A Word of Advice.

The number of our theoretically trained men th are being turned out yearly from our technic schools and colleges are rapidly increasing, and there every sign of a still greater supply of one-sided ele tricians. It is therefore about time that some out was made against the misleading and rather high-flo prospectuses that are constantly being sent to pare of the middle and upper middle classes regarding th short expenditure of time and the small expenditure money required in qualifying for the profession of ele trical engineering. There are several inaccuracies these, which do not escape the eye of a practical an commercial man. There is hardly any field nowaday for a man who has only spent a few months at a schoo where they teach "the best grouping of batteries" and other feats of mathematical gymnastics which neve once in a hundred times occur in actual practice. Usually at the head of the letterpress there occurs some highly coloured statement that anyone who has a short time in the laboratory will be, at the expiration of the course, a fully qualified electrical engineer, and will be able to command between £100 to £200 pe annum. Very few well trained men who have served a complete apprenticeship with a good firm will begin at anything like £100 per annum. It is a pity that ministers, doctors and lawyers into whose hands these missives should fall, are so easily made to believe that their sons can be turned into trained electricians in the short space of time and with small expense quoted by these gentlemen, and that without any workshop training or practical acquaintance with engineering. It is but useful now to mention one other point, and that is, the expression that this "a field not yet overcrowded," may be the opinion of those who turn out book-learned electrical engineers, but it is not the opinion of those who are practically engaged in it. This one word of caution may do good in drawing attention to a state of affairs which is hardly creditable to those who have caused it.

Gerald Day.

April 22*nd*, 1889.

The Recalescence of Iron.

I send you herewith a brief note in regard to phenomena which bear relation to those recently brought out by Dr. J. Hopkinson, which may be of interest to your readers.

Elihu Thomson.

Lynn, Mass., *April* 12*th*, 1889.

[Prof. Thomson's interesting communication appears in our other pages.—EDS. ELEC. REV.]